THE

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THE BOARD OF TRADE OVERHEAD WIRE REGULATIONS.

IT is well known that during the last two years efforts have been made by the London Chamber of Commerce, and by various firms of manufacturers and contractors, to obtain some relaxation of the overhead wire regulations issued by the Board of Trade, more especially of the clause relating to the thickness of dielectric required for high-pressure cables; and that, if we may judge from the comments of the technical Press and its correspondents, the general opinion of electrical engineers is very decidedly in favour of an alteration of the rule; indeed, so far as we are aware, no one during this time has come forward to support the rule, until Mr. Preece, in his paper "On the Specification of Insulated Conductors," quoted it with approval, and proposed that nearly similar thicknesses of dielectric should be specified for underground mains, explaining at the time that the rule was based on the striking distance of various pressures in air, but that a greater thickness than this striking distance was specified both by the Board of Trade and himself, because they had to anticipate what might take place when cracks and fissures occurred in the insulating media.

In the discussion which followed, every speaker who referred at all to this question gave it as his opinion that the striking distance in air had really nothing to do with the thickness of dielectric required to stand the same pressure; and we were, therefore, in hopes that Mr. Preece, having appeared in the character of advocate for the Board of Trade rule and his own, would deal fully in his reply with the question of the connection between striking distance in air and thickness of dielectric. Our disappointment, then, was considerable when we found, on referring to the recently issued number of the Journal of the Institution, that Mr. Preece's communicated reply consisted only of two short paragraphs, in the first of which he said that he could find nothing in the discussion to which he had to reply, as the speakers had so thoroughly answered one another, whilst the second which referred to the Board of Trade regulations ran as follows:—"It is clearly forgotten by the speakers that the Board of Trade rule for aerial conductors, printed at p. 613, was recommended by the Council of this Institution itself to the Board of Trade, and was in consequence adopted by that department. It was arrived at after considerable discussion and inquiry by a committee of the Council. Mr. Crompton was a member of this committee. It admits a thoroughly practical and useful standard, from which the thickness of the insulating medium can be determined, and it is the only standard that has as yet been suggested for high pressure feeders and mains."

If this is the best argument that can be brought forward in favour of the rule, its advocates must be in a very bad way, as we cannot see why the speakers should not have

discussed the question as they did, even if they had the clearest recollection of the fact that it was recommended by the Council ; for it must be remembered that many of them had no chance of expressing their opinions on the subject at the time the rule was approved, and, further, that there has been plenty of opportunity, during the time that has elapsed since its framing, for those who might have allowed it to pass then to have modified their opinions on the subject.

It would be extremely interesting to know exactly what arguments were adduced by members of the committee for and against the proposed rule, and how much practical experience of the working of high pressure aerial lines each member was able to bring to bear on the question, as it has been suggested on several occasions that the committee as a body agreed to the rule without realising its practical effects when applied to small conductors. But even if the decision arrived at by the committee some three years or so ago, was come to after obtaining the best available evidence and after due consideration of the question, it seems to us absurd, when we consider the rapidity with which our experience in all matters electrical extends, that anyone should suppose that that decision must necessarily hold good now, or that it should be brought forward at the present time as a sufficient answer to the arguments of those who took part in the discussion.

There is also a quaint touch of humour in the fact that such an argument should be used by Mr. Preece, as the Post Office, not being bound by these rules, avail themselves to the full of their right to erect overhead lines which entirely fail to comply with the regulations laid down by the Board of Trade as to the wind pressure and factors of safety which must be allowed. These regulations say that 50 lbs. per square foot must be taken as the wind pressure, and that factors of safety of 6 for the line, and 12 for the poles must be allowed ; but Mr. Preece some years ago, in papers read before the British Association, stated that their experience at the Post Office showed them that a wind pressure of 18·75 lbs. per square foot, and a factor of safety of 4, were sufficient to allow in calculating the strains ; and although he apparently considers that the decision of the Council of the Institution is infallible, and as final as the laws of the Medes and Persians, so long as it only concerns the unfortunate electric light contractor, he evidently thinks that his own figures are better when it comes to a question of Post Office lines, as the instructions issued by the Post Office are still, we understand, based on these figures.

With regard to the concluding sentence of this remarkable apology, for we can hardly call it a defence of the Board of Trade regulations, we cannot recognise the standard as either a practical or a useful one ; in our opinion, it is based on an assumption which is most unpractical, viz., that the dielectric must be made so thick, that even when there is a hole in it there shall be no discharge ; and its chief use, so far as we can learn, has been to hinder electric light contractors, by reason of the inordinate expense, from using a class of cable which many engineers, including, we believe, both Mr. Preece and Major Cardew, consider to be the best for overhead high pressure work. We may mention also that the standard referred to is not the only one that has been suggested for high pressure mains, as a memorial, addressed to the Board of Trade in November, 1890, by several firms interested in this question, proposed a modified rule,* which named $\frac{1}{16}$th of an inch as the minimum thickness of dielectric for 2,000 volts, and further specified that this thickness should not be less in any cable than one-seventh of the conductor diameter, and that the cables should have an insulation resistance of not less than 2,000 megohm miles when tested in water at 60° Fahr., after immersion for 60 consecutive hours. This proposed rule is, we consider, a decided improvement on the existing one, since it recognises that there are variations in the conductor diameter and in the quality of the dielectric material which must be taken into account, and if it were further amended, as suggested by us in some comments published at the time, by the addition of a clause specifying for a high pressure test, we think it would meet the case as well as any general regulation that could be proposed.

THE DESIGNING OF DYNAMO-ELECTRIC MACHINES.

The paper read by Mr. Loomis on the above subject before the electrical section of the Brooklyn Institute, and reprinted in our last issue, contains one or two statements which are very much at variance with the now accepted ideas of dynamo design on this side of the water, and show, if we may take them as fairly representing American theory, that the true functions of the polar air gap, as explained by Messrs. Esson and Swinburne in their papers on dynamo design, have not yet been fully appreciated in America.

The statements we particularly refer to are to be found in the following paragraph of Mr. Loomis's paper :—"Another extremely important point is that of diminishing the air gap by winding the armature with only one layer of wire. This reduces the resistance of the magnetic circuit, and renders it less liable to distortion under the varying currents delivered by the armature. If it were possible to find a suitable magnetisable substance which was at the same time a good conductor of electricity (say like copper), I think we could build what might be termed a commercially perfect dynamo (that is of this class) ; for with no air gap we could keep the polar line of the field perfectly steady. Consequently, what is termed the neutral or non-sparking points on the commutator would never shift, and that trouble, known as sparking, over which electricians have heaved so many sighs, would be for ever at an end. As this dream is certainly not realised at the present time, the next best thing we can do is to approach it as nearly as possible by reducing this air gap to its lowest limit."

Although the winding of the armature with only one layer of wire has many advantages, the reduction of the resistance of the magnetic circuit by diminishing the air gap does not lessen the distortion of the field due to currents in the armature, and we fear that if the dream referred to by the author of this paper could be realised, he would not find that the troubles due to sparking would cease as soon as he got rid of his air gap. Although in England practical experience of the limitation of the sparkless current carrying capacity of armatures had shown some engineers the import-

* Electrical Review, November 28th, 1890.

ance of the air gap, we do not believe that its effect was fully recognised until the reading of the papers referred to above; but as soon as the matter had been put before them, the correctness of the general theory was accepted, and the air gap, which had previously been looked on principally in the light of a wasteful consumer of magnetising force, came to be recognised as an absolute necessity, if the volume of current, to use the term suggested by Mr. Esson, was to be large.

The data given by Mr. Loomis of a 16 kilowatt dynamo at 1,400 revolutions are, unfortunately, incomplete, but there is sufficient to show us to what the principles laid down by him have led. We find, for instance, that the volume is 4,500, and that the total induction in the armature is 1,320 English lines, whereas practice here would probably double the volume at least, and reduce the induction in the armature in inverse proportion, thus making a much smaller machine give the same output; and this without experiencing any trouble from sparking or losing anything in the way of electrical efficiency as compared with Mr. Loomis's machine, which has by no means a very high one when we consider that it runs at 1,400 revolutions per minute.

The Purification of Sewage by Precipitation.

In a paper read by Mr. J. Barrow a short time ago, before the Manchester section of the Society of Chemical Industry, some interesting figures were given respecting the amount of albumenoid ammonia contained in the effluents from the five different processes of sewage purification which can at present claim to be "in the field." These statistics are, perhaps, worth recording here for reference in connection with the question of sewage disposal by means of electricity, especially as so few statistics appear to be available.

Albumenoid Ammonia in Sewage Effluents in parts per 100,000.

Authority.	"International" system.		Authority.	"Electrical" process.	
Dr. Burghardt	... 0·8	... 0·7	Mr. Carter Bell	... 0·25	... 0·11
„	... 0·15	... 0·4	„	... 0·32	... 0·17
„	... 0·5	... 0·64	„	... 0·27	... 0·1
„	... 0·3	... 0·07	„	... 0·13	... 0·12
„	... 0·14	... 0·31	„	... 0·092	... 0·25
Mr. Carter Bell	... 0·2	... 0·06	„	... 0·23	... 0·27
„	... 0·17	... 0·12	Dr. Burghardt	... 0·1	... 0·27
„	... 0·15	... 0·14	„	... 0·26	... 0·34
„	... 0·16	... 0·12	„	... 0·4	... 0·1
„	... 0·05	... 0·105	„	... 0·3	... 0·4
„	... 0·06	... 0·15	„	... 0·15	... 0·17
„	... 0·04	... 0·24			
„	... 0·41	... 0·18		"Alumino-ferric" process.	
			Dr. Burghardt	... 0·5	... 0·3
	"Lime" process.		„	... 0·46	... 0·32
Mr. Carter Bell	... 0·27	... ...	„	... 0·36	... 0·3
„	... 0·305	... ...	„	... 0·4	... ...
Dr. Angus Smith	... 0·66	... ...			
„ (after irrigation)	... 0·21	... ...		"Clarine" process.	
Dr. Wallace	... 0·4	... 0·24	Mr. J. Barrow	... 0·025	... 0·02
„	... 0·35	... ...	„	... 0·05	... 0·02
			„	... 0·009	... 0·03
			„	... 0·15	... ...

We give these figures upon the authority mentioned. We have had no opportunity of verifying them for ourselves, and this was the case, also, with our article on the "Economic Aspect of the Sewage Question," to some of the figures in which the "International" Company took exception.

An Electrical Method of Manufacturing Oxygen on a Commercial Scale.

The manufacture of oxygen on the large scale is an industry which to-day has assumed commercial proportions. Compressed oxygen gas is now regarded as a necessity in some branches of manufacture whereas a few years ago it was only looked upon as part of the equipment of the "magic-lantern man." There are several economical methods of obtaining oxygen which are being exploited, chief amongst them being that adopted by the "Brin" Company. It may be considered certain now, owing to the numerous attempts to obtain this gas cheaply from chemicals, that no process is likely to be economical which does not depend upon the extraction of oxygen from the great store of it which exists in the atmosphere. Hence we should think that the promotors of the new method of tapping this supply, which employs also electricity in effecting its purpose, are likely to meet with success. The new process is a "continuous" one, and consists essentially in passing ozonised air through a compound capable of readily absorbing the oxygen, and of giving it off again when heated in a current of steam. The method of working is to draw air by means of a fan through an electric ozone generator which contains a number of plates made of glass or some other insulating material. The plates are varnished, and coated on their upper sides with perforated tin or other metallic foil. These foils are connected alternately with the terminals of the high potential circuit of an induction coil. The air on leaving the ozone generator passes to a retort in which is placed the substance capable of absorbing the oxygen from the air, such, for example, as commercial manganate of soda, which may be mixed with oxide of copper. The retort is heated in a furnace, and is provided with a pipe and cock for the admission of steam, and also with an exit pipe through which the liberated oxygen can pass through a washer to a gas holder, a bye-pass being provided for the escape of the nitrogen. The sodium manganate is first treated with steam and the evolved oxygen collected. When no more gas is evolved the steam is turned off, and the ozonised air led through the hot retort when re-oxidation ensues, the oxygen taken up being again liberated on a second treatment with steam. By employing an arrangement of four retorts, this process can be worked continuously.

Electrolytic Separations.

For the benefit of those of our readers who are interested in the separation of metals by means of electrolysis, we call attention to several papers which have recently appeared on this subject, but which we cannot notice at length. The electrolytic deposition of gold from alkaline auro-cyanides is well known, and E. F. Smith and F. Muhr have now demonstrated how this property may be applied to the separation of the precious metal from palladium, platinum, copper, cobalt, nickel and zinc (*vide Berichte der deutschen chemischen Gesellschaft*, xxiv., pp. 2,175—2,181). There are papers on the same subject in the *Journal of the Franklin Institute* of last year No. xiii., pp. 206—209 and xiii., pp. 144—150. The latter is by L. K. Frankel, and deals with the electrolysis of the metallic sulphocyanides. Mercury and gold are the only two metals whose sulphocyanides gave satisfactory results; all the others were more or less unsatisfactory. The former paper treats of the electrolysis of metallic phosphates in acid solution. It appears that, so far, the electrolysis of zinc, nickel, cobalt and iron phosphates have not yielded encouraging results. Strong currents seem necessary; even then the deposition of the metals is rather slow. The *Berichte* also contains a paper by Smith and McCauley on the electrolytic separation of mercury from copper (*vide* pp. 2,936—2,938, vol. xxiv.). They find that by carefully regulating the current the separation is complete, even when the copper is present in twice as large a quantity as the mercury; and the presence of zinc, nickel or other metals in no way hinders the action.

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FIGURES FOR ELECTRIC LIGHT PRODUCTION.

By W. H. BOOTH.

(Continued from page 449.)

III.

Probably in looking round for information with regard to the advisability of adopting some general type of engine or boiler, the non-technical man responsible, perhaps, for the spending of public money, will be confronted with many subjects, and his attention demanded to questions which even practised engineers hardly care to tackle.

One of these questions will, perhaps, be that of forced draught, and it will be pointed out that by means of forced draught, enormous results can be obtained from small boilers, many people never thinking themselves so clever as when they are proposing to draw quarts of liquor from pint pots. Now it is all very well to insist upon the fact that with forced draught a small boiler will do as much work as a large one. This is not the case *in toto*; there are various meanings attachable to the term large, as applied to a boiler.

It may be of large external dimensions, or it may be packed full of heating surface in the shape of many tubes, or it may have a large grate area, but in any rational design the ratio of the grate surface to the heating surface must be such that the true ratio aimed at is that between the coal consumed and the heating surface.

Any boiler burning 10 tons of coal per week, and doing so with economy as regards the duty of each pound of coal burned, expressed in evaporation units, will probably become an uneconomical boiler if so forced as to burn twice the weight of coal, and yet have no increase of heat absorbing surface.

This idea is carried out in practical boiler construction very fairly.

An ordinary semi-portable boiler of locomotive type may have a firebox as large as that of a locomotive; it may have a barrel of equal length, but if examined it will be often found to have, perhaps, some 60 tubes of moderate diameter, whereas the actual locomotive will have treble the number of smaller tubes of much greater total surface. Clearly this is the outcome of the fact that the locomotive boiler will be called on to burn coal at the rate of 50, 80, or 100 lbs. per square foot of grate surface per hour, whereas the semi-portable boiler will be doing well if it gets a draught sufficient to enable it to burn 20 lbs. per square foot. Further, if the semi-portable be too much urged, the furnace gases will be unable to part with their heat to the boiler, and the result will be, perhaps, a hot smoke box. This is very commonly seen.

In the early days of locomotives, after the virtues of the steam blast had been discovered, it was common enough to see locomotives with their chimneys red hot, simply because the area provided for absorbing heat had not then grown to the ratio per ton of coal which the heat demanded.

It was on the question of red hot chimneys that George Stephenson confounded the examining counsel in committee who referred to the fright of animals at such a sight as a red hot chimney, by asking, "How would they know it wasn't painted?"

It is therefore pertinent to enquire into the question of this much-belauded forced draught in order to ascertain what points should be attended to in its adoption, for it is a process of coal combustion which cannot be adopted in any sort of haphazard fashion at will, any more than it would be proper to suddenly begin to work at 100 lbs. pressure some old Boulton and Watt engine—say from the South Kensington Museum. The truth is, that there are modes of forced draught by which the whole action of a furnace is ignored; there are upholders of the system who have only the most hazy notions of the practice of steam raising or the chemistry of combustion, and who will not listen to advice from practical firemen, but go blindly on running their heads against the laws of nature.

To begin with, we should understand what forced draught is or should be, and to do this it is well to know what it should not be. On this point we may say that a furnace full of bright fire, clear and white, and spurting up tongues of flame from the fire surface is by no means necessarily a good steam raiser, either in respect of quantity or economy, but very often it is just the opposite of both these. Such a fire may be obtained at any time by means of a powerful fan draught blown under the grate in a closed ashpit beneath a fire of ordinary thickness. There is intense combustion and a large supply of air, and as the fire is thin, very large quantities of air pass untouched through the grate and diminish the mean temperature of the furnace to such an extent that the efficiency is rendered low. This is the kind of forced draught which some men advocate, and it is absolutely useless.

These very men will point to the locomotive as an example of a powerfully forced draught of greater intensity than the fan blast which they are using, and will, from it, endeavour to disarm criticism, but in doing so they altogether overlook essential factors.

Anyone who will go to the trouble of watching a good fireman at work for a few days, or even a few hours, will note one or two salient points in his practice.

He will note that when fresh fuel is added, care is taken to fill the hollow places in the fire, and that firing is frequent and by small doses. There will be a careful endeavour to cover every portion of the grate surface, for the good fireman has learned by experience that to make steam, he must do his best to stop the ingress of air through the grate, so far as he can do it with coal. He does not level the fire with the rake to any great extent, though if it should burn into hollows arched over, he will crush such down; but all levelling will be done if possible by filling with fresh fuel into the hollows. Neither will he admit any more air at the door above the fire than is absolutely necessary. Some he will let in at the air grids during the evolution of the hydrogens after fresh fuel is put on, but he will close this off gradually as the fuel becomes coked. Should the demand for steam be heavy on any special occasion, and the engine run slow for want of sufficient steam, the engine man may be seen to enter the boiler house and, when firing is going on, he will stand by the furnace doors and open these for each shovelful of coal just as it is thrown on, and will close the door while the fireman is simply picking up the next shovelful.

Now this ought to be pretty conclusive proof that too much air must be guarded against. Rankine's statement that ordinary furnaces consume about double the amount of air chemically necessary to effect complete combustion, may be taken as fairly representing the practice of to-day; but it has been shown that this is not necessary, for, by a proper adjustment of the furnace, Mr. M. Longridge has succeeded in reducing the excess of air by something like 9 lbs., or from 25 to 14 lbs. per lb. of coal. This he did by using a thicker fire, a smaller grate area and a more fully opened damper. The particulars of this test may be found in one of Mr. Longridges annual reports as Chief Engineer to the Engine Boiler and Employers Liability Association.

From a consideration of the results of different practice, we may infer that ordinarily, air enters a furnace in excess, and this is the more marked at hollow parts of the fire; at these areas air pours in in streams, and is not even touched it may be by the fuel, but simply gains heat and reduces the mean furnace temperature. Fuel cakes up into such curious lumps, and burns into such fissures, that when the fire is apparently 6 inches thick, it is full of free passages from the grate to the fire surface. In a thicker fire lumps are perhaps no bigger, and fissures fill up spontaneously, and, under a very great depth of fuel, no caverns could exist at all; they would crush in. Experiment has shown that an increase of fire thickness up to a maximum possible, in the size of furnace used for the experiment, of 14 inches, with natural draught, continued to be accompanied by increased economy. Is it not therefore extremely reasonable to conclude inferentially, that, as with natural draught we do not reach a maximum efficiency with a 14 inch fire, it will therefore be of little use to apply a forced draught to any fire less than 14 inches in thickness. If this be done it appears to be similar in its effect to reducing the fire thickness, for clearly, as with natural draught, a 14 inch fire still admits more than sufficient air, so must an increase of air pressure demand a similar increase of fire thickness. This brings round our argument again to the locomotive, and we begin to perceive that this can usefully withstand the heavy draught of a steam blast, simply because it has a deep firebox, and can be deeply filled with fuel, and we obtain the

combination of thick fire and heavy draught, and this combination is necessary to economy with forced draught; the fire thickness must, in fact, have some ratio to blast intensity.

What this is there are probably few data to show outside the locomotive, but what it is not is such that the blast can burn a hole through the fuel before the next firing, or can carry off lumps of fuel from the surface of the fire. The fire thickness must be such that it completely breaks up the blast, which should arrive at the surface partially reconverted to carbonic oxide to be burned by air admitted above the fuel.

Now a special and peculiar cause of the success of forced draught on locomotives lies outside the question of the application of the system to stationary boilers. This special factor is vibration and shock. The running of the locomotive over the best of rails is accompanied by considerable shake. This cannot fail to consolidate the fire by breaking down cavernous places, and shaking loose fuel into the hollows, so preventing the burning of bare places on the grate.

If this reasoning be correct, and it will scarcely be argued that there is not a considerable show of probability in it, then for stationary purposes the depth of fuel to correspond with that in a locomotive must bear a higher ratio to the blast than it does in a locomotive, for it lacks the consolidating effect of vibration, which we may point out is practically the basis of the economy which has been found to attend a finger grate capable of being shaken by hand, or automatically at intervals.

Attempts to apply forced draught to Lancashire boilers have not been successful, because for ordinary sizes of furnaces in such boilers it is not easy to maintain such a depth of fire as is most economical, even with a natural draught. Similarly, forced draught has been far from an unalloyed success in marine work, for we hear much of the leakage of tubes. It is easy to understand that when a stokehold is worked under a plenum, and the furnace door is opened for firing purposes, there must be, unless special means be taken to close the dampers for such occasions, an enormous inrush of air at the open door direct to the chimney; a sudden chilling of the tubes is thus produced with the reasonably expected results in leakage; of course, too, when the furnace door is open, it offers the easiest road or line of least resistance to the chimney, and by this road will go all the air possible, to the stoppage of any air *viâ* the fire grate and through the resistance of the fuel on the grate. When the closed ash pit is employed, this, of course, cannot happen, for unless regulated to prevent it, the opening of the furnace door is as likely as not to be accompanied by an outrush of flame, the air pressure forced in by the fan being greater than the capacity of the chimney and flues to carry away; hence the red hot doors so frequent with the closed ash pit system of forced draught.

A further disadvantage of this system is, that no air can be admitted above the fire to combine with the gases given off by the fuel—more especially the hydro-carbons, and a chance of reducing smoke is thus lost.

On the whole, therefore, it would appear that when forced draught is employed it should be applied on that system which admits it to both ash pit and doors in order to give the best results in working, but in no case can forced draught be properly utilised without proper supervision in more than ordinarily intelligent stokers, nor is its use advisable unless boilers of special arrangement are there to utilise its advantages.

Assuming, however, that a boiler is suitable for forced draught in respect of dimensions sufficient to give the necessary depth of fire, we may conclude that it is not well to burn a greater total weight of fuel in that boiler than it would burn with the natural draught for which it was designed as regards its ratio of grate to heating surface. To secure this end, it is usual to reduce the grate area, so that though combustion takes place at a higher speed it does so over a less area.

Ordinarily reduced grate areas is obtained by shortening the length of the bars employed, but it is open to question whether an equally good, if not a better plan, would be to reduce the width of the air spaces between the bars so as to produce the same effect—a reduction of the total air opening—the furnace length being unchanged. The effect of this would be to introduce the air in thinner sheets, and it would be better deprived of its oxygen, for we may take it as favourable to economy that little or no oxygen should find its way uncombined to the surface of the fire, but that a further supply should be added from the door to complete the combustion of the carbonic oxide and the hydrogens which are evolved from the green coals on the fire surface.

Now, forced draught enables us to get air into a fire to which natural draught would not force it in such fine streams, and this appears to be the direction in which forced draft should be made to act. With huge grate openings, poorly covered by a thin bed of fire, forced draught cannot fail to pour in vast volumes of utterly useless and unnecessary air, and yet it is only by reducing the air supply as near to the chemical minimum as possible, that any economy can arise from the system.

Forced draught promotes combustion, but it does not increase in any way the calorific power of the fuel in any degree whatever, beyond the indirect action which arises from a diminution of the useless air; heat expended on air now going to the boiler. Thus it is that in practice slow combustion boilers are so often most economical, simply because their miserable draught is commensurate with the fire thickness, and air is not admitted uselessly.

Practical firemen will tell us that a large grate area is a better steam raiser than a small one, even though the total coal burned is the same in the two cases. There is reason to believe that there are grounds for this opinion, in the probable fact that a surface of incandescent fuel is efficient as a radiator of heat to the boiler, whereas mere hot gases have poor radiation. If this be allowed, though experiment is wanting to determine the actual facts, then, in the application of forced draught, it would appear sound practice, as indicated above, to preserve the superficial fire area, and reduce the area of air space in the grate itself, while increasing the fire thickness into which the more forcible air jets are blown.

In the Lancashire boiler, even when as much as 8 feet in diameter, the furnace diameter is only 40 inches, and as the grate is nearly half way up, there is only 20 inches to 22 inches space above its centre to the crown of the furnace, and this does not admit of so very deep a fire, for there must be some space above the fire to pass away the products of combustion.

Again, it is exceedingly difficult to get firemen to keep up the thick fires, which are known to be so much more economical than thin ones, and though so eminently good a boiler, it is not so suitable for strongly forced draught as the deep firebox type, though of this latter, or locomotive type, it must be said that unless a deep fire be maintained, it is not an easy boiler in which to obtain a well covered grate.

The locomotive type boiler possesses advantages for electric stations where space is a special desideratum, and forced draught is desired to be employed, for in such a case we have ready to hand a type of boiler of marked success when worked with forced draught, and which, with suitable modification, may be fairly well applied to stationary work, into the particulars of which we may now enter.

(To be continued.)

THE ELECTRIC RAILWAY IN THE SALT WORKS AT NEU-STASSFURT.

[FROM OUR OWN CORRESPONDENT.]

Neu-Stassfurt carries on the exploitation of its considerable rock salt and potash beds for the present by means of two shafts situate near each other, the "Agatha" shaft, 316 metres in depth, and the "Hammacher" shaft, 360 metres deep.

The electric railway there, which was brought into regular work at the beginning of the year 1884, is on the 60-metre deep level of the "Agatha" shaft. From this shaft there leads a cross cutting driven 83 metres in an easterly direction, from the end of which the main adits arranged for the electric expedition of the potash salts are driven into the salt 900 metres to the north-west and 650 metres to the south-east. From time to time, as the excavation advances, the installations for electric transport in the main adits are extended.

Concerning this electric installation for transmission, the following remarks may be of interest.

By day a steam engine of about 16 H.P. is fixed at the distance of 25 metres from the shaft. It serves to actuate the primary dynamo, *i.e.*, the one generating the current. The engine makes 50 revolutions per minute, and drives the primary dynamo, which makes 650 revolutions per minute.

The primary dynamo is fitted with two electro-magnets fixed one above the other, which include between them the drum armature. These electro-magnets have a double winding, so that this dynamo belongs to the class of the so-called compound machines. By using this class of machine, the advantage is secured that the electromotive force remains the same, whether the secondary machine driven by the electric current generated—that is, the electromotor driving the locomotive—has to work with a greater or less expenditure of power within the given limits, so that its velocity of rotation remains approximately constant without special regulation.

Further, in these compound-wound dynamos the motive power required is always proportionate to the electric work performed, so that the dynamos yield a very high useful effect.

The secondary dynamo, serving as electro-motor, is so constructed that the two horse-shoe magnets, embracing the drum armature between their poles, are arranged horizontally, in order to keep the height of the machine moderate.

The primary machine works with a tension at the terminals of 350 volts, and requires for its action about 20 H.P., so that, in this case, the work of about 10 H.P., performed at the electromotor, may be maintained. Hence the electric installation gives a useful effect of 50 per cent.

The electric current of about the strength of 42 ampères is conveyed from the primary machine by means of two conducting cables formed of copper wires, to the shaft, down through it, and along the cross cutting above mentioned, therefore for about 410 metres in length to the conducting rails of T-iron, placed insulated above the line. Along these rails glide the two contact sledges, conveying the current to and from the locomotive electromotor. The contact sledges are connected with the terminals of the electromotor by short conducting cables, so that by means of these contact sledges the locomotive electromotor is introduced movably in the circuit of the primary machine in order during the journey to convey the electric current from the conducting rails to the electric motor, so as to set its armature in rotation. From the revolving shaft of the armature of the electromotor the rotation is conveyed to the driving wheels of the locomotive without shocks.

The electric locomotive is 930 millimetres long, 1,500 millimetres in height, 2,670 millimetres in length between the buffers, and 480 millimetres between the middles of the axles. The gauge is 628 millimetres, and the diameter of the driving wheels 350 millimetres. The form of the locomotive is symmetrical, with a seat at each end for the driver, so that at each direction of the journey he has to take his place at the hinder end of the locomotive, he thus has a clear view of the distance before him. In front of each seat for the driver are two handles, the one for moving the ordinary mechanical brake, the other for connecting, disconnecting, and turning round for each journey of the locomotive. In order on connecting and disconnecting the electromotor to avoid a too great increase of the current, with consequent damage to the coils and the connected mechanism, electric resistances are gradually inserted or withdrawn according to circumstances, by turning the above-mentioned second handle, which reduces the current correspondingly by conversion into heat. These resistances are placed above on each side of the locomotive in long boxes, with grated sides, and consist of narrow bands of wire gauze.

As regards the performance of the electric locomotive, the following data are given for its calculation :—

The weight of the locomotive is 2,174 kilos. On this weight the tractive power exerted by the locomotive depends, modified, however, by the nature of the line, since the adhesion of the wheels is affected by the greater or less smoothness of the rails, and an uneven, jolting, more or less ascending line wastes a corresponding part of the tractive power. According to experience, if the line is very good, one quarter of the weight of the locomotive is available for tractive force ; if the line, though horizontal, is very slippery, perhaps covered with sheet-ice, only $\frac{1}{25}$th part is effective, so that as a mean $\frac{1}{4}$th of the weight is assumed as available for tractive power. In the conditions prevailing in the mine in question a rather smaller fraction of the weight of the locomotive is available as effective power of traction, since the line is rendered slippery for the locomotive by the water allowed to trickle over it in order to remove the crust of salt which deposits itself upon the rails. This same moisture, on the other hand, serves as a lubrication for the wheels of the following trucks, which run more readily upon this slippery line and thus assists the tractive power.

The tractive force of the locomotive amounts in this case at the utmost to $\frac{1}{10}$th of the weight of the locomotive, or about 200 kilos. As the locomotive moves the loaded train, consisting of 16 trucks, besides the water car for washing the rails, at a speed of about 3 metres per second, we may calculate the effective performance of the electric locomotive at $\frac{200 \times 3}{75} = 8$ H.P.

The gross weight of a loaded truck is, on the average, 1,200 kilos., so that a train consisting of 16 such loaded trucks and the water car weighs, in round numbers, at least 20,000 kilos. ; if we assume that this weight, upon an almost horizontal line, can be overcome with x kilos. per 1,000 at the speed of 3 metres, by the 8-H.P. of the locomotive, the calculation takes the following form :

$$\frac{20 \times 3 \times x}{75} = 8, \text{ or, } x = \frac{8 \times 75}{3 \times 20} = 10.$$

That is the resistance of the train which a locomotive has to overcome, at the velocity of 3 metres, amounts to 10 kilos. per thousand, which, taking into consideration the very smooth line and the good condition of the trucks, is, in any case, a close approximation to the truth.

It must be remembered here, that under less favourable circumstances, the resistance may increase to the double and the threefold, whereby, of course, the speed of transit for the same, or even for a higher demand upon the locomotive power is correspondingly interfered with. In the present case the locomotive would probably, without any appreciable decrease of its speed, be able to draw a longer train, perhaps as much as 20 trucks, since the electric cars are very strongly built.

As to the working costs, the following figures, supplied by the management of the mines, are decisive :—

In the year 1884, when from January 1st to December 31st a total of 176,196 trucks were conveyed on the two tracks (the north track being then 580 metres in length, and the south track 450 metres), the working cost, calculated as a monthly average, and taking into account all single items for wages, fuel, materials, repairs, and 15 per cent. for interest and sinking fund on an original capital of 35,000 marks, came to 10·1 pfennige per truck, whilst the previous conveyance by human labour came to from 18 to 20 pfennige per truck in the year's average.

Of the 176,196 trucks despatched in the working year 1884, approximately 105,718 trucks were conveyed on the north line of 580 metres, and 70,478 on the south line of 450 metres, so that the year's load appears as :—

$$105{,}718 \times 0{\cdot}8 \times 0{\cdot}58 = 49{,}153{\cdot}2 \text{ kilometre tons.}$$
$$70{,}478 \times 0{\cdot}8 \times 0{\cdot}45 = 25{,}372{\cdot}1 \text{ kilometre tons.}$$

consequently the yearly conveyance was 74,525·3 kilometre tons.

For the total yearly conveyance there was expended in working costs $176{,}196 \times 10{\cdot}1 = 1{,}779{,}579{\cdot}6$ pfennige, for which we put in round numbers 1,780,000 pfennige. For the kilometre ton the cost of transport is consequently

$$\frac{1{,}780{,}000}{74{,}525{\cdot}3} = 23{\cdot}89 \text{ pfennige.}$$

Whilst transport by human labour comes per kilometre ton close upon 45 pfennige, as a labourer obtained for 100 truck metres, or 0·08 kilometre ton, 3·6 pfennige. The electric transport comes up much more favourably on working days, when the installation is taxed to its utmost duty.

During heavy work in February, 1884, the number of the trucks conveyed in 87 working shifts of eight hours each, was 23,868, and the total cost of conveyance (inclusive of interest and sinking fund) was 1,491·36 marks, so that it was 6·2 pfennige per truck, and the ton kilometre transported electrically comes only to 14·7 pfennige.

For the year 1887 the transportation on the electric lines came up still more favourably, since the northern line had been extended to 900 metres and the southern line to 650 metres. In March of this year, trade being good, there were conveyed 20,114 trucks on a mean extent of 800 metres, corresponding to 12,873 kilometre tons. The average total costs of conveyance (including interest and sinking fund on a capital outlay of 40,000 marks at 15 per cent.) was 8·3 pfennige per truck, or 12·92 pfennige per kilometre ton as against 34·2 pfennige per kilometre ton by human labour, so that the cost for electric conveyance in comparison with human labour is $\frac{12·9}{34·2} = 0·38$; that is, 38 per cent.

This result, very favourable for electric conveyance, is confirmed by the following summary of the working costs of electrical lines in the salt mines at Neu-Stassfurt, in the Royal Saxon coal pits at Zaukerode, near Dresden, and in the coal pits at Beuthen, near Upper Silesia, that is, under decidedly different circumstances.

Comparison of Conditions and Costs on the Electric Mine Lines at Neu-Stassfurt, Zaukerode and Hohenzollern.

	Stassfurt.	Zaukerode.	Hohenzollern.
Mean distance traversed, metres	800	720	756
Maximum trucks per shift	400	400	900
Load per truck in kilos. ...	800	475	550
Machinist, daily	0·9045 pf.	0·3120 pf.	0·611 pf.
Train service, daily	2·2000 „	0·8000 „	
Fuel for steam	1·7900 „	0·3400 „	0·222 „
Sundry materials	0·5685 „	0·6735 „	0·333 „
Repairs	0·3276 „		
Interest and sinking fund, 15 per cent.	2·4856 „	1·0150 „	1·778 „
Total	8·2762 pf.	3·1405 pf.	2·944 pf.

Cost of Conveyance by Human Labour.

	Stassfurt.	Zaukerode.	Hohenzollern.
Trucks per shift	18 pf.	7·2 pf.	7·5 pf.
Trucks per 100 metres ...	2·9 pf.	1 pf.	1 pf.
Per kilometre ton ...	34·2 pf.	21 pf.	18 pf.
Proportion of electric conveyance to conveyance by human labour ...	0·38 pf.	0·44 pf.	0·37 pf.

Conveyance by Horse-power.

Per kilometre ton ...	16 pf.	12·2 pf.	10 pf.
Proportion of electric conveyance to horse-power	0·75 pf.	0·75 pf.	0·67 pf.

A STORAGE BATTERY LOCOMOTIVE.

AN electric locomotive has recently been put in operation at the Baienfurt paper mills near Ravensburg, in Wurtemberg, to travel between the works and the Niederbiegen railway station, which is 2½ miles distant. The peculiar feature of the locomotive is the fact that it is arranged both to haul a waggon, and to carry passengers and light goods inside. It constitutes an open waggon, the only protecting piece of roof being placed over the driver. Seats for passengers are provided on either side, and under these are arranged the storage batteries which energise the motor. The cells are of the Oerlikon type, with a gelatinous electrolyte, and are one hundred in number. The weight of these cells, which can be put all in series, two in series, or four in series for different speeds, is 2 tons. The motor is fixed to the under-frame, and drives the axles by means of toothed gearing. The total weight of the locomotive is 8 tons.

The line upon which the waggon runs is of normal gauge with very light gradients. A fully loaded goods waggon, containing 20 tons, can be hauled from the station to the works in 20 minutes, and the locomotive makes on an average four journeys daily. The battery is handled by one of the machine attendants without the supervision of an electrical engineer. That this can be safely and efficiently accomplished is attributed to the use of the gelatinous electrolyte in the cells, and which is claimed to ensure a greater working safety than when a fluid electrolyte is employed. The Oerlikon Engineering Works equipped and supplied this locomotive, and the engineers believe that their system will at no distant date remove the mistrust which obtains against the storage battery method of electric traction, and also render this method commercially successful on a large practical scale.

HIGH TENSION AND HIGH FREQUENCY EXPERIMENTS.

A PARTY of about sixty well-known electrical engineers met in the Prince's Room, at the Crystal Palace, on Wednesday the 13th instant, at the invitation of Messrs. Swinburne & Co., to witness some high tension experiments.

The energy was derived from a 100-unit Brush alternator, at a tension of 2,000 volts. The largest current flowing at any one time during the experiments was about 20 ampères; and so it would seem that the maximum energy used was about 50 H.P. The circuit was arranged according to fig. 1,

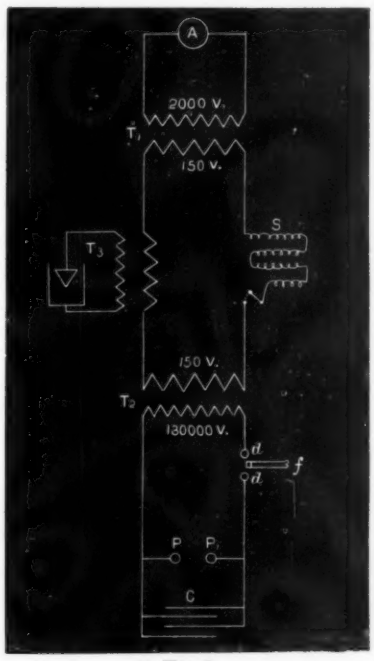


FIG. 1.

in which A is the dynamo, T_1 a step-down transformer used to reduce the 2,000 volts to 150 volts, which was the E.M.F. of the primary of the high tension step-up transformer shown at T_2. The regulation of the current in the high tension primary circuit was accomplished thus: first, there was a make and break and reducing switch at S; and, secondly, at T_2 there were a couple of small transformers in parallel (coupled thus merely for convenience and shown in the diagram as one). These had their primary circuits in series with the secondary of T_1 and the primary of T_2; and their secondary circuits were varied by a water resistance. The tension of T_2 could be thus regulated between a few thousand volts and the highest E.M.F. obtainable under these conditions. In series with the secondary of T_2 was placed a large condenser, C, roughly built up on the spot and thus only safe for some 20,000 to 30,000 volts. This was accordingly only used for the high frequency experiments which did not require a higher voltage. The frequency was increased by an air blast such as used by Prof. Elihu Thomson. At *a* and *d*, the terminals of the high tension circuit, were arranged two brass knobs and sparks jumped across the intervening distance in an apparently continuous stream. About the centre of the arc was placed the nozzle of a foot bellows, *f*, so that the sparks were interrupted by puffs of air. The effect

on the current was somewhat as indicated in fig. 2. By this means some fine Tesla effects were got. The Geissler tubes were hung at P, fig. 1, at about 12 to 18 inches above the condenser, C, the top sheet of which was in connection with the other pole of the transformer. Small pieces of tin-foil were attached to the lower ends of the tubes so as to increase their capacity.

With the high tension experiment at the frequency of the Brush alternator, the condenser and the air bellows were removed and the apparatus used was simply placed between the high tension terminals, P and P_1 (fig. 1).

The experiments shown were not altogether novel, but since the tension used was perhaps the highest yet obtained

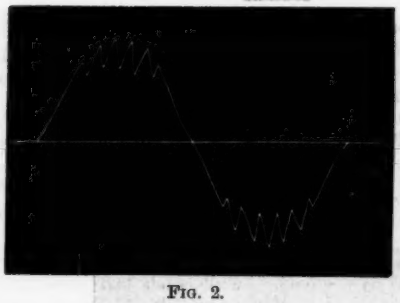


Fig. 2.

Fig. 3.

from a transformer in this country, they are noteworthy. The point of chief practical interest, indeed, was the large transformer of commercial design, with a conversion ratio of from 150 to 130,000 volts.

The most important experiments were :—

1. *Long distance Arcing.*—The points used were steel hair-pins, and with the maximum potential the arc formed through 6 inches of air, but it failed to do so at 6½ inches. The tension was given as about 130,000 volts. The points were then changed for polished brass hemispheres about 4 inches in diameter, see fig. 3, and it was found that the arcing distance was reduced to about 2½ inches. It was also noted that the arcs did not damage the polished surface of the metal.

2. *Long Arcs* (fig. 4).—The arc was first started at the ends, of two pieces of thin iron wire, and as the wires burnt so it increased in length, curling and twisting upwards,

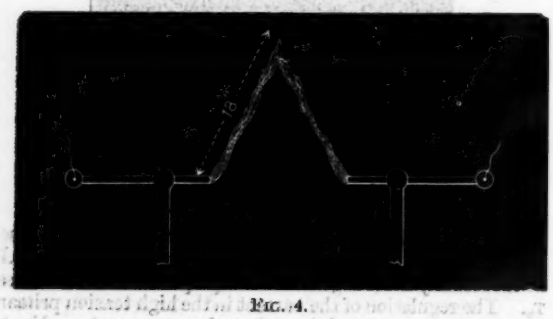


Fig. 4.

until a length of about 3 feet was attained. At the same time a roaring sound was emitted. The rising of the arc is probably due to the mutual repulsion of the parts of the flames, as much as to the heating of the air.

3. *Slate as a Conductor.*—Two pieces of slate pencil were mounted like the carbons in an arc lamp, and until broken by the heat, they gave a feeble light. As the lecturer put it, one candle-power was obtained from one horse-power. Next an ordinary roofing slate supplied by Captain Russell, general manager of the Crystal Palace, was placed with the terminals about one-half of an inch from each end. As soon as the voltage rose sufficiently two arcs were formed at the ends of the slate, clearly showing it to be a conductor.

4. *Wood as a Conductor.*—A piece of white deal, part of an egg box, was treated in the same way as the slate; and soon streaks of fire scintillated amongst the fibres of the wood and shortly it burst into flame.

5. *The electric Octopus.*—This pretty high tension experiment is well known, but probably it has never been shown better in public before. The first piece of glass was $\frac{1}{16}$ths of an inch in thickness and about 2 feet square. Before the glass was punctured, the current continually leaped over the edges, giving a spark about 2 feet in length. There seemed to be a large increase in the frequency owing to these oscillations of the current. The puncture in the glass was not sealed as is usually the case. The same experiment repeated with plate-glass, $\frac{3}{16}$ths of an inch thick, failed to pierce a hole, and the current did not arc over the edges.

6. *Oil as an Insulator* (fig. 5).—This was an experiment to show that an oil insulation is not self-repairing if the energy of the circuit be considerable. The oil used was Mr. Wilcox's resin oil, and appeared to be a good sample. The spark was struck through $\frac{1}{4}$ of an inch of oil, the two leading-in wires being separated by 3 inches of air. When the arc was once formed, a continuous flame resulted, accompanied with smoke, thus proving that such an insulator is not self-repairing under the conditions of high tension work. Messrs. Swinburne & Co. state that when a transformer "arcs," it always has to be rewound—this confirms Continental experience.

7. The repulsion effects between a charged point and the surface of oil were next shown. The experiment was ar-

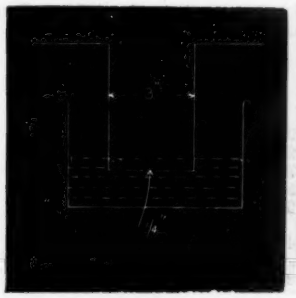


Fig. 5.

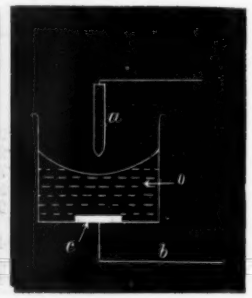


Fig 6.

ranged as shown in fig. 6, where *a* and *b* are the high tension terminals, *b* being connected to a plate of metal, *c*, at the bottom of the jar. As the potential between the point and the plate increased the surface of the oil was repelled, and it assumed a concave form as indicated at *o*. This is probably of more scientific than practical import.

The experiments were performed by Mr. W. Fox Bourne, Mr. Swinburne introducing the subject with a few explanatory remarks. Altogether the *séance* was most interesting, and considering the importance of high tension work in the immediate future, the guests were indebted to Messrs. Swinburne & Co. in no little degree, and they certainly returned to town with much food for thought. The subject especially brought into prominence was the insulating properties of various materials when subjected to high tensions such as 20,000 volts and upwards. It appears that the whole question will require to be reconsidered, for materials which act as insulators at low tensions, become conductors when the pressure is raised sufficiently. This fact is being slowly forced upon us by experience; and no doubt now that the road is indicated, practice will soon develop arrangements suitable for the new conditions of working.

ELECTRICAL DISTRIBUTION BY ALTERNATING CURRENTS AND TRANSFORMERS.

By RANKIN KENNEDY.

Some six years ago the only example of a distribution by alternating currents and transformers in Great Britain was a small affair at the Grosvenor Gallery, London; since then the system has been largely adopted throughout the country. Experience and ingenuity have brought forth improved generators and transformers and methods of working, but there cannot be said to be any advance made in the simple alternating current and transformer system of distribution in any fundamental detail since its introduction six years ago. Manufacturing firms and contractors hurried into the

market with the system in its simplest form, and it has been adopted in many cases somewhat too hastily. Large plants have been erected and large sums expended on them by companies in London and elsewhere, only to find that they have a system not fully developed and limited in its application.

This simple alternating current system has its advantages and good points; it is a system eminently fitted for the requirements of pioneer work where customers are few and far between, and each customer requires a transformer for himself.

But it is becoming more and more apparent that, as a system for distributing on a large scale, it is a failure, and that those people who are adopting it as a system in its simplest form are making a mistake; it may work all right at the outset in supplying electric lights, but when the demand extends and electricity is wanted for motive power, for arc lights, for electrolysis, and many other purposes, the simple alternating system will be found wanting.

By adopting the use of condensers as proposed by Mr. Swinburne, some of the difficulties in working alternating currents are lessened, the large magnetising currents can be met thereby, but any motor requiring a condenser must be a dangerous machine to handle, a low pressure condenser being quite impracticable. The motors available, or rather the motors proposed for working with the simple alternating currents, are either synchronous motors, that is, reversed alternators, or motors with condensers counteracting the self-induction of the field magnets, the pressure being some thousands of volts at the field coil terminals.

The only drawback to the synchronous motor is that they require some starting arrangement, and do not start with the load on. In some cases these drawbacks are not of any importance, but in most cases they are prohibitive, especially for small powers. Yet gas engines were used and sold by thousands at a time when they were not self-starting, and would not start with any load on, so that it would seem that self-starting with a load on is not absolutely necessary in all cases. Later on a method of starting synchronous motors will be described.

The motors with condensers in their design need not now be discussed; they are not to be had yet for practical work. The condenser is an obvious difficulty itself, both as to cost and in introducing high pressures.

Looked at from all points of view, the alternating current has one important application in distribution schemes; there is one function it can fulfil better than any other current, and if used rightly for that alone it will maintain a very important place in the electrical distribution of energy.

It is now admitted that the sub-station scheme of distribution is the plan for the future.

The electrical energy is to be generated at one generating station, delivered to the sub-stations, and from thence to the consumers. Large quantities of electrical energy, such as is required for sub-stations, can be delivered economically only at high pressures, so that transforming is an absolute necessity; that being so, the alternating current is the current to deliver the energy to the sub-stations; it can be so easily generated and transformed, compared with the difficulties in generating and transforming continuous currents. This gives the alternating current enormous advantages, but these advantages are confined entirely to the transmission of the energy between generating and sub-stations, and if its operations are confined to that, the full benefits arising from the use of high pressure alternating currents are obtained.

The author has for some years had these considerations in view, and has made many endeavours to arrive at a scheme of distribution in which the high pressure alternating current feeders are used for transmission between generating and sub-station, and in which the high pressure alternating current is transformed and converted into a continuous low pressure current for distribution among consumers.

This scheme takes advantage of all the benefits in the use of high pressure alternating currents and low pressure continuous currents, using each in its most advantageous position.

The whole question as to the feasibility of such a scheme turns on the possibility of transforming the high pressure alternating currents into low pressure continuous currents at the sub-stations.

One method proposed by several inventors consists in using an alternating motor to drive a continuous current generator. This plan is, in the first place, not very economical except at full load; in the next place, it requires the use of large power machines at the sub-stations, so that their first cost would be large, and special sub-stations constructed for them would also be costly, and difficult to obtain in towns.

There is no other method of converting a single alternating current into a continuous current at present known.

It is therefore necessary to adopt multiphase currents.

Multiphase currents can, by means of transformers and a synchronously driven commutator, be converted into practically continuous currents.

The system then resolves itself into this: the generators are two-phase or three-phase alternators. These supply the sub-stations at high pressure with two-phase or three-phase alternating currents. These currents are each separately transformed down at the sub-stations, converted into low pressure continuous currents, and then distributed.

Accumulators may be used at the sub-stations, and charged up by the converted currents.

Large consumers are treated as sub-stations, and get a high pressure feeder; if for lighting purposes alone, the currents are only transformed; but if for light and power, the currents are also converted into a continuous current. This scheme also contemplates the taking in of all already existing distribution plants. A low pressure continuous current supply station can be made a sub-station, dispensing with the engines, boilers and dynamos, and getting a supply through a feeder from the high pressure station.

Simple alternating current high pressure distribution plants can be altered to send out two-phase currents or three-phase currents, instead of one single current, and thereby they would be in a position to feed continuous current sub-stations, and immensely increase the sale of electrical energy for all purposes. Customers would be able to use any of the numerous motors for continuous currents; they could store their supply, and the current would be used for electro-chemical and electrolytic work, whereas at the present moment customers on simple alternating current supply can do none of these things, and the alternating current generating station cannot feed a continuous current sub-station.

A two-phase current is quite easily converted, and gives a continuous current steady enough for all practical purposes, and it is not a difficult matter to arrange existing alternators to produce two-phase currents for the purpose. Some alternators can be made to give two currents in quadrature phase, simply by winding in another series of armature coils between those already in use. The Kapp alternator, for instance, can be thus easily altered to give two currents in quadrature, and at the same time nearly double its output.

Other alternators require to be coupled in pairs or duplicated, to give the two currents in quadrature.

Continuous current dynamos of any make can by a very simple alteration be made to give two alternating currents in quadrature phase; in fact it is the easiest thing imaginable to either alter existing machines, or build machines to give two alternating currents in quadrature phase.

Whether two-phase currents or three-phase currents are employed, three wires are required as high pressure feeders; with three-phase currents rather less copper is required in the third wire than with two-phase currents.

In this article, only the outline sketch of a system has been given; in the next some of the apparatus and machinery employed in carrying the system into practice will be fully illustrated and described.

The introduction of two phases or three phases into alternating current work looks at first sight to be something amazing to people who are already perplexed over alternating current problems dealing only with simple currents, but on further acquaintance with the multiphase currents it will be found that the use of more than one alternating current simplifies the practical working of electrical distribution problems very considerably. In these articles the multiphase currents are treated only as transmission currents, continuous currents derived from them by conversion being employed for distribution.

It may be said that we can get light and power from multiphase currents themselves, and that, too, with commutatorless motors; that is very true, but multiphase commutatorless motors are far from perfect; they require a 20 horse-power transformer for a 2-horse motor; these

motors require enormous exciting currents, and therefore are not yet in that state of perfection to compete with common continuous motors on a distribution plant, and three or two-phase currents have no advantages in lighting up lamps.

As transmitters of electrical energy for conversion into continuous low pressure currents they are invaluable, and in such a case they are destined to take a place which no other currents can fill.

A method for converting one ordinary alternating current, such as is supplied by the existing alternating current systems in use, consists in using a dynamo for producing two currents in quadrature as a motor which runs in synchronism with the supply current; one of the circuits being energised by the supply current, drives the machine in synchronism with this current, and there is generated in the other circuit another current in quadrature phase with the supply current by two commutators on the shaft of the motor; these two currents can be rectified into one continuous current.

By this plan a sub-station can obtain a supply of continuous current from any of the existing alternating current plants. It, however, involves the use of dynamos of a size equal to supply the whole continuous current required at the sub-station.

As a ready means of extending the operations of alternating current suppliers into the continuous current consumers it is the simplest method now known. Simply put, this method consists in deriving a current in quadrature phase from the simple alternating current, rectifying both into a continuous current by commutators.

Some astonishment has been expressed at the reluctance supply companies' engineers have shown in the way of taking up the sub-station system in place of the high pressure network and house transformer system. But this reluctance can be understood clearly when it is considered that hitherto no workable plan for making sub-stations centres of supply of continuous currents has been available.

In the next article the quadrature generators and the converters will be fully discussed and illustrated.

(To be continued.)

NOTES.

Rockhampton Electric Lighting.—According to the *Financial News*, the Rockhampton (Queensland) municipality has accepted the tender of a Sydney firm of electricians to supply the township with electric light. The installation is to be completed by the end of July.

Portsmouth and Electric Lighting.—The members of the Electric Lighting Committee held a public exhibition outside the Portsmouth Town Hall recently of lamps by different manufacturers suitable for the electric light, on which it is proposed so spend £60,000. Much interest was evinced in the lamps, the candle-power of which varied from 400 to 1,000.

The Fairfield Shipbuilding and Engineering Works.—Through the kindness of Mr. Andrew Laing, chief engineer of the Fairfield Shipbuilding and Engineering Works, Professor Jamieson and about 300 of the engineering students from the Glasgow and West of Scotland Technical College, visited the above works on Saturday, 16th inst., where they saw the hulls, boilers, and engines of the two largest Cunarders in a most interesting stage of progress.

Electric Telegrams in Paris.—A Paris correspondent of the *Morning Post* states that from the 1st of May next a new mode of correspondence will be placed at the service of the Paris public, namely, a system of sending messages from one part of Paris to another by electric telegraph instead of by pneumatic tubes as at present. This will serve to complete the present organisation, which already comprises telegraphic cards and telephonic messages. The "electric telegrams" will be charged at the same rate as ordinary despatches, that is to say, five centimes (½d.) a word, with a minimum of 50 centimes (5d.).

Chicago Exhibition, 1893.—We are informed that Her Majesty's Government having increased to £60,000 the grant of £25,000 originally made for the purpose of the British Section at the Chicago Exhibition, the Royal Commission for that Exhibition are enabled to dispense with the revenue it was proposed to raise by charging the exhibitors in proportion to the extent of space occupied, and that therefore all space in the British Section will now be granted free of charge.

Electric Treatment of Refractory Ores.—The *Times* states that an important method of treating metalliferous ores, especially those containing gold, has been brought to a successful issue by Mr. Hannay, the well-known chemist. High tension alternating currents are applied to the most refractory ores in such a manner that complete separation of the metal takes place without the use of chemicals. Plant is now under construction for some of the most important mines.

Poisoning by Electricity.—An electrical workman of Berlin was recently poisoned in a very peculiar manner, which, says the New York *Electrical World*, it will be well for electricians to note. In testing his cells, to see if current was flowing, he was in the habit of putting the two ends of the wires in his mouth, and the soluble salts of copper produced eventually caused his death. The galvanometer is now substituted in that workshop for this rough and ready test, which evidently is more dangerous than most persons would believe.

Experiments with the Electric Trams at Bradford.—Experimental runs were made on the 12th inst. with the electric tramcar at Bradford up the steep curve leading from Forster Square along Cheapside to Manningham Lane. The car has been specially built by the Lancaster Waggon Company. It has seats for 18 persons inside and a like number outside. With the motors, it weighs 6½ tons. The overhead posts and wires have not been favourably viewed by the Bradford public, and it is said that when the experiments have been fully completed the poles will be removed, and any further extension of tramways in Bradford carried out upon the three-rail underground electrical system.

An Immense Submarine Cable.—Under this heading the *Electrical Age* states that the International Okonite Company, Limited, recently shipped from its factory at Passaic, N.J., to go south, a two mile submarine cable in one length, composed of 20 conductors. Its total weight was upwards of 70,000 lbs. Its manufacture was accomplished through the agency of new machines which have recently been put in operation at the Passaic works, and tends to show the progress made by the company in not being satisfied with remaining quiet, but continually endeavouring to improve its machinery for the production of high class insulated wires and cables. [Perhaps to Americans a cable weighing about 15½ tons per mile is really immense.]

Toynbee Hall Science Conferences.—A lecture was delivered on Wednesday evening, April 13th, by Mr. Reginald J. Jones, M.I.E.E. and A.M.I.C.E., on "Electrical Installations," the subject being illustrated by lantern slides and many interesting experiments. From actual practice, the average cost for five years of the gas used in a London house for driving the gas engine for an installation of 43 lamps was shown to have been only £11 12s. per annum. Storage of electricity was illustrated practically by E.P.S. cells lighting the lecture hall, &c. Some positive plates were shown which had been in daily use for six years in a private installation, and a new form of cell called the "Epstein" was exhibited, which promises to yield good results for electric traction and central station work, &c. The practical and theoretical conditions which govern the wiring of houses, &c., were fully illustrated and explained by slides, tables, experiments, and types of the most modern fittings. We would like to ask concerning the gas engine figure above given: How many hours a day were the lights used, for how many days in the year, and of what candle power were the lamps? Without these items of information for guidance, we fail to see the value of Mr. Jones's actual practice, and it is a wonder that one of the audience did not challenge the usefulness of such a statement.

Proposed Lighting of a Welsh Asylum by Electricity.—At last week's quarterly meeting of the Carmarthen Joint Counties Asylum, it was reported that the committee of visitors had considered the feasibility of lighting the Institution by electricity, instead of gas as at present, and it was decided to ask Mr. J. C. Howell, electrician, Llanelly, to report upon the matter at the next meeting of the committee.

Electric Communication between Lightships and the Shore.—A meeting is to be held at the Mansion House on the 26th inst., under the auspices of the National Sea Fisheries Protection Association, in support of the resolution to be moved on the following evening in the House of Commons by Sir Edward Birkbeck, urging the Government to take steps to establish electric communication between lightships, lighthouses, and the shore, for the saving of life and property at sea.

Oldham and the Electric Light.—At a special meeting of the Oldham Town Council held last week, it was resolved that Professor Kennedy's scheme be adopted throughout. At present it is intended to light only dwelling houses, the Infirmary, the Science and Art Institution, the Free Library, banks, and other public buildings, and not the streets. Several members of the Council had visited London at the request of Professor Kennedy, and inspected the engines in actual operation.

Exeter and the Electric Light.—The Exeter municipal authorities have decided to reconsider the question of street lighting by electricity, and the surveyor has been instructed to prepare a report, giving: 1. The present annual cost of lighting the streets within the area set out in the second schedule to the Exeter Electric Lighting Company's provisional order. 2. To prepare a plan showing the number and power of electric lamps required for the same area. 3. To prepare an estimate of the first cost of lighting. 4. To obtain from the Exeter Electric Lighting Company an estimate of the cost per annum for the supply of light as per plan, and any other information that may assist the council in coming to a decision. At the City Council meeting the discussion on the subject was of a very lengthy nature, and an amendment against the reconsideration of the scheme was lost by a large majority.

The Electric Light in Preston.—Preston, Lancashire, was the first provincial town to adopt gas as an illuminant, and the community will not be far behind with regard to utilising electricity as an illuminating power. Messrs. Latimer Clark & Co. are laying down an extensive plant which will light the shops of Fishergate and the other principal streets of the town. A good site for the central station has been acquired near Lancaster Road, and power is provided by ten engines and dynamos with five boilers for lighting 50,000 8-candle-power lamps. Although the installation will not be complete until about August, there has already been a test of the mains, which was attended with satisfactory results. The Corporation have contracted with the National Electric Light Supply Company for the public lighting of the whole of Fishergate, the principal street of the town.

Patents in France.—Mr. J. G. Lorrain writes to us as follows:—"On the 2nd inst., the last of the patents applied for in France during 1891 was issued, and the figures for that year can now be determined. A few of these may be of interest to your readers:—French Patents.—During 1891, applications were made in France for 8,079 new patents, and for 1,467 certificates of addition, making 9,546 applications in all. Of the 8,079 applications for new patents, 7,863 were granted, 28 were rejected, 184 were withdrawn, and four are in suspense. Of the 1,467 certificates of addition, 1,429 were granted, 34 were withdrawn, and four are in suspense. In the department of telegraphy and telephony, 90 patents and 17 certificates of addition were granted. In the division dealing with generation and distribution of electricity, 199 patents and 42 certificates of addition were granted. In the division dealing with the applications of electricity, 170 patents and 30 certificates of addition were granted."

The Electric Light Question at Bideford.—At the Local Board meeting on Thursday last week, on the tender of the Bideford Gas Company being read, the electric lighting question was reopened. It was urged that it would be very unwise to accept a gas tender for anything like three years. There was a great desire in the town for the electric light, and the Lighting Committee should get information as to the cost, &c., of providing the electric light. A motion in favour of the gas company's tender being accepted for one year was lost, and an amendment was carried in favour of accepting no tender until the negotiations between the gas company and the Lighting Committee were fully understood.

The Proposed Engineering Exchange.—At the meeting of the Civil and Mechanical Engineers' Society, on Wednesday evening last week, a paper was read by Mr. Reginald Bolton, Vice-President, on the subject of the Engineering Exchange. The object of the paper was to demonstrate the close connection existing between the interests of Westminster engineers and the mercantile branch of the profession located in London. Mr. Bolton concluded with the hope that the considerations he had brought forward would impress on professional engineers advantages of association with an institution formed for general convenience, and which was destined, with their co-operation, to become powerfully representative and worthy of that science of which the key note is progress, and of the age in which it has been inaugurated. A discussion followed, in which a number of members took part, when opinions expressed by the author were reinforced by facts related by several speakers, and some pertinent instances were given of the important purchases and sales conducted by civil and consulting engineers, and the establishment of the exchange was admitted to be of great value to them. The author, in replying, invited anyone interested to visit the temporary premises of the exchange in the exceedingly commodious and convenient club rooms of the "Jerusalem," Limited, Billiter Street, E.C., and stated, as Chairman of the Exchange Committee, that the opening would take place on May 2nd, previous to which circulars and application forms would be sent round the entire profession, as far as possible. A hearty vote of thanks to the author closed an interesting evening's proceedings.

Note on the Oscillations of Hertz.—In a recent memoir Mons. V. Bjerknes has shown that the oscillations of electromotive force produced around conducting wires by the method of Hertz may be represented by the expression

$$\gamma = A\, e^{-\alpha(t-\theta)} \sin \pi \left(\frac{t}{\tau} - \phi\right)$$

This work can be consulted in the *Archives des Sciences Physiques et Naturelles*, Vol. xxvi., p. 227, or in *Wiedemann's Annalen*, Vol. xliv., pp. 74 and 92. Mons. A. Potier has undertaken research upon similar lines but using a different exciter namely one of the kind used by Mons. Blondlot a short time ago in an investigation which is described in the *Journal de Physique*, 2nd series. Vol. x., p. 549. At the weekly meeting of the Academy of Science at Paris, held on January 25th, Mons. Potier gave an account of his work; this is reported in the *Comptes Rendus*, Vol. cxiv., No. 4, pp. 165—168, and is illustrated with curves and tables. It appears that with the apparatus employed it is possible to excite a resonator and to measure the length of the wave, and Mons. Potier in the experiments which he performed considers that it is impossible to explain the phenomenon called "multiple-resonance" otherwise than as it is explained by the theory concerned by Ponicari (*vide Archives des Sciences Physiques*, Vol. xxv., p. 609) and supported by Bjerknes and Blondlot.

A Fever-Stricken Telegraph Steamer.—The Western Brazilian Telegraph Company's steamer, *Viking*, arrived at Leith last week for repairs from Rio Janeiro. It was reported that while at work off Brazil in the beginning of the year yellow fever broke out, carrying off seven of the crew. At one time the epidemic was so bad that the crew were paid off and the vessel deserted. On the voyage home several took ill and had to be landed at various places. The steamer was built in Dundee nine years ago, and this is the first time she has come home to be overhauled.

Electro-capillary Phenomena.—The comparison of amalgams of mercury from the point of view of electro-capillary phenomena, which was made some weeks ago by Mons. Gouy, and duly noticed in these pages, has led him to study the law which governs these phenomena, when pure mercury and various aqueous solutions are experimented with. In the case of a certain class of electrolytes, it has been shown by Lippmann that this law holds accurately, but generally speaking differences more or less great and sometimes important are observed. The phenomena observed in the cases of pure mercury and aqueous solutions of potassium, chloride, bromide, sulphide, and sulpho-cyanide form the subject of a paper by Mons. Gouy, in the *Comptes Rendus*, Vol. cxiv., No. 5, pp. 211-214. These phenomena cannot be translated into any agreement with the theory of "double layers" proposed by Helmholtz, at least if that theory be kept in its present form. This rather serious discrepancy demands further investigation, and it is to be hoped that the somewhat obscure, but extremely interesting phenomena of electro-capillarity will receive attention from others besides the distinguished scientist who is at present engaged upon it.

Maximum Torque in Motors.—The following is a copy of a letter which recently appeared in the columns of the *Engineer* from a correspondent:—"I shall be very much obliged to any of your readers who will tell me what are the conditions of maximum torque in motors. I mean the static angular effort of the armature when at rest to cause rotation. The conditions contemplated are those present in tramcar work. The car is propelled by a motor and gearing. The armature makes about 800 revolutions per minute as a maximum, and is geared down with a hide pinion running in a gun-metal spur wheel; when the car is stopped, and has to be started again, a very great effort is needed. The armature is standing still, and must overcome this resistance before it can move; under these circumstances I wish to know what is the best kind of armature, field magnets, winding, &c., to employ? I have no doubt that if I were a mathematician I could work out all this for myself, but I am not. I suppose, however, that the mathematicians have arrived at certain more or less simple rules, such as I could use without troubling myself to know how the rules were obtained. I read a great deal of current electrical literature, but I cannot find anything which I can understand bearing on this question. Perhaps I may venture at the same time to ask on what the rotating effort of the field magnets is exerted? Do they attract the copper wire or bars of the armature? or do they attract only the iron core on which the wires are supported? or is the current of electricity flowing through the copper which is acted on by the lines of force flowing from the poles of the field magnet? Would an advantage be gained if iron wire were used to wind the armature instead of copper? I know that about seven times the weight of wire would be needed; but if I could get anything like a double torque this would not stand in my way. Any information will be appreciated by NON-MATHEMATICS."

Relation of Voltaic Electromotive Force to Molecular Velocity (By G. Gore, F.R.S.)—In a recent research published in Vol. 8, p. 63, of the *Proceedings Birmingham Philosophical Society*, 1892," it is shown by means of an extensive series of 64 tables of measurements of *mean* volta-electromotive force, that the *dilution* of the liquid of a voltaic cell by means of water or alcohol, the *liquefaction* of either the positive or negative metal of the cell by means of mercury, the *dilution* of either of these amalgams by means of mercury, the *dilution* of one solid metal by means of another in an alloy, is universally attended by an increase of *mean* electromotive force of the diluted and diluting substances, and consequently also of the *actual* electromotive force of the diluted one, provided that in all cases no chemical union or other chemical change occurs in the mixture. The manifest explanation of this extensive general result is, that by the act of solution or dilution, the molecules of the active substance are separated farther apart, and consequently acquire increased velocity of motion. In proportion, however, as chemical union occurs, the gain of electromotive force diminishes and is converted into a loss, and the loss is larger in proportion as the chemical union is stronger. The method enables chemical compounds in alloys, amalgams, and electrolytes to be distinguished from mere mechanical mixtures.

Electric v. Belt Power.—It is commonly supposed that electric motors are chiefly suitable for transmission of power over long distances. This is not the case, however, says *Industries*, and the time is now come when it will pay to use copper conductors instead of belting, even in small factories. Our contemporary calls the attention of machine shop-managers to the great superiority of electrical transmission of power over that by belting, and enumerates the numerous advantages. Objections will, of course be raised on the score of expense but it must be remembered that a very much smaller steam plant would be needed, and at the same time there is a great deal of waste power where belts are used, whereas in an electrical system, the dynamo has to supply only the power actually needed, so that quite a small engine and dynamo will drive a large shop. This engine and dynamo will probably cost less than the large engine now necessary. In addition to this saving of otherwise wasted power, there would also be a large saving in the coal bill and another advantage with direct currents, is, that there would be a constant speed. It is scarcely to be expected that works managers will remove their belts and counter-shafting to replace them by motors in existing shops; but before making any further extensions it would be wise to consider the motor and lighting question carefully, and with our contemporary we feel sure that this will result in adopting motors, and eventually in the gradual replacing of belts throughout the works.

The Magnetic Properties of Heated Iron.—During the last five years special attention has been given by eminent metallurgists in this country and on the continent, to the question of the effects of temperature upon the properties of the metals. Our knowledge in this branch of research has been pushed forward so rapidly as to suggest almost boundless possibilities for discovery. This was never more patent than at the Royal Institution a few weeks ago when Prof. Roberts-Austin lectured upon "The metals at high temperatures." This able metallurgist has himself largely contributed to our knowledge of the metals, and has especially helped us to a proper understanding of that curious phenomenon known as "recalescence." The lecturer first traced the development of research work in apparatus for accurately determining high temperatures, referring particularly to the instruments used by Boyle, Siemens, and Le Chatelier. He appeared to give the palm to the electrical method of ascertaining temperature, and showed how sensitive is a "balanced" current of electricity to heat changes, mentioning Callender's recent investigations, by which it is now possible to determine temperatures of over 1,000° C. to within $\frac{1}{10}$th of a degree. Amongst other interesting phenomena which were discussed, the professor called attention to the fact, that iron at a full red heat had its molecular constitution much modified, for at this temperature its magnetic properties disappear, but upon reaching a temperature of about 700° C., or a medium red heat, its immediate regain of magnetic properties became apparent.

Recent application of Electricity to the Manufacture of White Lead.—Ammonium acetate is used for dissolving the litharge in the production of basic carbonate of lead—the so-called "white lead" of commerce. The solution is ordinarily used over and over again, and in course of time becomes impure through taking up considerable quantities of copper—an impurity in the litharge. One of the latest improvements employs carbonic acid gas for removing every trace of metal from the acetate, but another improvement, which is said to be even more effective, is to pass through the solution an electric current, electrodes of carbon being employed. In another application of electricity to white lead making, the metallic lead itself is decomposed in an acid electrolyte into an oxygen bearing salt of the metal; the saturated solution being then neutralised, and the salts contained in it being converted into hydrated lead carbonate. The latter is precipitated by the introduction of carbonic acid gas.

The Electric Light in Japan.—The annual meeting of the Shinagawa Electric Light Company was recently held, when a dividend of 5 per cent. was declared. As the business of the Mita line of this company is rapidly increasing, it has been decided to erect another generating station at Fudanotsuji, Mita, and the work has already been commenced.

St. Pancras Electric Lighting.—The St. Pancras Vestry on Wednesday adopted a report from their Electricity Committee recommending the extension of the electric light in the Euston Road, from Euston Station to King's Cross, and (after negotiations with the London Street Tramways Company) in Hampstead Road and High Street, Camden Town. The installation, so far, was described as a commercial success.

The Lighting of Lime Street Station, Liverpool.—The London and North-Western Railway Company is laying down electric plant in Lime Street Station. It is intended to light the whole of the station and offices, and all the rooms in the hotel, by electricity.

Pier Electric Lighting.—It is stated that the proposed new pleasure pier at Penarth will be lighted with electricity.

Midland Railway Company and Electric Lighting.—The *Daily News* states that the Midland Railway Company are about to introduce the electric light into all their offices at Derby, and also at the Midland Hotel. The installation will cost about £11,000.

New Aluminium Works in Germany.—A *Standard* correspondent telegraphs that an English company is about to establish aluminium works on a very large scale at Philippsheim, in the Eifel Mountains. Near that place there are extensive clay strata, from which the metal is to be won, with the help of water power supplied by the River Kyll.

Electric Light Accident and Fire in St. Petersburg.—An accident occurred to the electric lighting apparatus in the Winter Palace at St. Petersburg on Easter Day. The lights in the Palace Chapel, where the Imperial family were attending service, did not go out, but amongst the officials and domestics in the other parts of the building, the sudden darkness and the ignorance of its cause gave rise to some alarm. A fire was then discovered in one of the small rooms near the roof. The electric light was replaced by oil lamps and torches. It seems, says the *Standard* correspondent, that the fire in the garret and the extinction of the electric light were very closely connected, a beam having been ignited by contact with an electric wire conveying a powerful current. The fire caused little damage.

Telephones in the United States.—A telephone Bill has been introduced in the Assembly with the object of creating a commission to determine the rates which shall be charged for service by telephone companies.

Submarine Cables in Russia.—It is intended to lay a submarine cable in the Caspian Sea during the present year.

Electric Tramways in Germany.—It is proposed to construct an electric tramway line between the towns of Zwickaru and Welkair, in Saxony.

Electrical Engineer's Pocket-Book.—A revised and enlarged edition of Mr. H. R. Kempe's "Electrical Engineer's Pocket-Book," published by Messrs. Crosby Lockwood and Son, is now in the press.

The Price of Aluminium.—A correspondent, referring to a paper by Mr. J. H. J. Dagger on "Aluminium," recently published, in which it is stated that the price of that metal is from 3s. 4d. to 4s. per lb., calls attention to the fact that the market price of the present aluminium has for many months been below 2s. 6d. per lb. With reference to the Cowles process, it may be mentioned that the latter and furnace has not been in commercial use for many months—a year is well within the truth. The Cowles Syndicate Company's parent in the States took over an employé from their Pittsburgh competitors, and have been for a year defendants in an infringement case in U.S.A. Fulfilling their contract with the purchasers of their English patents, the American Cowles Company have sent the process to the English company, and at present their works have been re-started, but not to operate the Cowles process.

The Electric Light in Germany.—The central station recently completed for the civil authorities of the town of Eisenach was put in operation on the 2nd inst.

Personal.—Mr. W. N. Rogerson, of Ealing, has been recently appointed electrician to the Peninsular and Oriental Steam Navigation Company's steamship "Parramatta." He qualified himself in the works of Mr. Ronald A. Scott, M.I.E.E. This is the fourth appointment during the last sixteen months given by the Peninsular and Oriental Company to members of the Acton Hill Works.

Mr. H. Goodwin has been appointed acting director of Telegraphs, Gold Coast Colony.

Electric Launches.—The specially built electric launch constructed by Messrs. Woodhouse and Rawson United, Limited, at their Chiswick Works, to the order of the Southport Corporation, for use on their artificial lake, was running during the Easter holidays with remarkable success. We are informed that this boat (*The Bonnie Southport*) will seat 40 persons, is 38 feet 5 inches, has 7 feet 6 inches beam, and draws about 2 feet 3 inches of water. She is carvel built of bright mahogany, with a large counter, and is propelled by a 5 horse-power "W. & R." motor.

Glasgow and West of Scotland Technical College.—Mr. Andrew Stewart has presented a handsome screw-cutting lathe to the Electrical Department of the Glasgow and West of Scotland Technical College.

Crystal Palace Electrical Smoking Concert.—We are glad to hear that after paying all expenses connected with this concert, there remained a surplus of 18 guineas, which amount was presented to the Norwood Cottage Hospital. The committee and secretary are to be congratulated upon such a favourable result.

The Cable to the Azores.—A *Financial News* telegram from Lisbon, on 20th inst., states that it is almost certain that the concession for laying the Azores cable will be granted to the French company. Thus France will control both this and the cable connecting France and Portugal.

NEW COMPANY REGISTERED.

Electric Cycle Syndicate, Limited.—Capital, £3,000 in £1 shares. Objects: To purchase or otherwise acquire letters patent, inventions, rights, and privileges (subject to royalty or otherwise) in connection with electrical or mechanical inventions or improvements; to carry on the business of electrical and mechanical engineers, and to experiment and test with the object of the propulsion of cycles and other vehicles by means of electricity. Signatories (with 1 share each): C. A. Edwards, Newton House, Bickley; J. W. Lance, 77, Palmerston Buildings, E.C.; S. H. White, 20, Clayland's Road, S.W.; J. Fletcher, 14, Albert Square, S.W.; E. J. D. Hewitt, 25, Comyn Road, St. John's Road, S.W.; G. R. Steward, 34, Amersham Vale, New Cross; H. M. Hutchins, 7, Thornbury Road, Clapham Park. Registered on the 12th inst., without articles of association, by Goldring, Mitchell and Philips, 20, Abchurch Lane, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Carbon Electric, Limited.—At an extraordinary general meeting of the members of this company, duly convened and held at the company's offices, 33, Old Broad Street, London, E.C., on February 17th, 1892, the following special resolution was duly passed and at a subsequent extraordinary general meeting, duly convened and held at the same place on March 5th, 1892, was duly confirmed: "Resolved, that the memorandum of association of this company, clause 5, be amended by dividing the capital of the company into 2,100 preference shares of £5 each, and 1,900 deferred shares of £5 each,

in place of the present division of the capital of the company" (3,000 preference and 1,000 ordinary shares).

Fareham Electric Light Company, Limited.—The annual return of this company, made up to the 24th ult., was filed on the 29th ult. The nominal capital is £5,000 in £1 shares, and 4,158 shares have been taken up. The full amount has been called and all calls, with the exception of £4, have been paid. Registered office, Westbury Lodge, West Street, Fareham, Hants.

Foreign Pilsen Electric Light and Power Company, Limited.—The annual return of this company, made up to the 15th ult., was filed on the 17th ult. The nominal capital is £30,000 in £1 shares, of which 29,800 have been taken up, all of which, however, were issued as paid. Registered office, 11, Abchurch Lane, London, E.C.

Electric Wirings and Fittings Company, Limited.—The annual return of this company, made up to the 14th ult., was filed on the 22nd ult. The nominal capital is £5,000 in £1 shares, and of these 1,382 have been taken up, the full amount called and all calls, with the exception of £7, paid. Registered office, 42, Duke Street, St. James's, S.W.

Birmingham House-to-House Electricity Company, Limited.

Lancashire and Cheshire House-to-House Electricity Company, Limited.

Manchester House-to-House Electricity Company, Limited.

Midland House-to-House Electricity Company, Limited.

Northern House-to-House Electricity Company, Limited.

Scottish House-to-House Electricity Company, Limited.

South of England House-to-House Electricity Company, Limited.

Western House-to-House Electricity Company, Limited.

The annual returns of the above-named companies, made up to January 11th, 1892, were filed on the 13th inst. Each has a capital of £100,000, divided into 19,900 ordinary and 100 founder's shares of £5 each. At the time of the making up of the return, 107 shares (100 founder's and 7 ordinary shares) were taken up, and in each case the founder's shares had been issued to the parent company (the House-to-House Electric Light Supply Company, Limited), as fully paid, in consideration for the payment of the preliminary expenses attending the formation of the companies. Upon the remaining 7 ordinary shares, no calls have as yet been made. The shareholders are in all respects the same in each company. Registered offices, Nos. 1 & 4, at the offices of Messrs. Baker & Gibson, Bennett's Hill, Birmingham; Nos. 2, 3, 6 & 7, at 15, St. Helen's Place, London, E.C.; No. 5, at 21, Grainger Street West, Newcastle-upon-Tyne; and No. 8, at 13, John Street, Bristol.

Corlett Electrical Engineering Company, Limited.—An agreement made the 2nd inst. between G. S. Corlett (the vendor) of the one part, and J. C. Kenyon (on behalf of the above-named company) of the other part, states that G. S. Corlett agrees to sell, and the company to purchase, the business of electrical engineers carried on by the vendor (formerly in partnership with M. Mercier) at Wigan, Bolton, and elsewhere, and that the purchase consideration is to be £1,000 in £10 shares (of which £750 is for the goodwill), the stock-in-trade, premises, &c., to be paid for in cash, according to the valuation of John Laithwaite, of Wigan. The vendor will be the managing director of the company for 10 years at £300 per annum, to be increased according to the dividends paid, or as the capital of the company is taken up.

Direct Spanish Telegraph Company, Limited.—The annual return of this company, made up to the 5th inst., was filed on the 14th inst. The nominal capital is £95,000, divided into 13,000 ordinary shares of £5 each, and 6,000 10 per cent. preference shares of £5 each. Of these all the preference, and 12,931 ordinary shares have been taken up, and upon the preference shares the full amount has been called, while upon the ordinary shares £4 per share has been called, resulting in the payment of £81,724, the full amount. Registered office, Winchester House, 50, Old Broad Street, London, E.C.

Liverpool Electric Supply Company, Limited.—The annual return of the above-named company, made up to the 18th ult., was filed on the 9th inst. The nominal capital is £200,000, in £5 shares, all of which are taken up. Of these 10,000 have had the full amount called and paid, while upon the remaining 30,000 shares £3 per share has been called. The calls paid (including sums paid in anticipation of calls) amount to £148,243 10s. Registered office, 15, Highfield Street, Liverpool.

Railway Electrical Fog Signal Syndicate, Limited.—The registered office of the above-named company is situated at St. Peter's Church Walk, Nottingham. (Filed on the 24th ult.)

ELMORE'S FRENCH PATENT COPPER DEPOSITING COMPANY.

The shareholders of this company are invited to attend at Winchester House, Old Broad Street, to-day at noon, to receive the directors' report and statement of accounts, and to transact the business of an ordinary general meeting. An "extraordinary resolution" will be proposed, increasing the capital of the company by the amount of £200,000 in preference shares. £120,000 is to be issued at once; the balance, together with a further issue of debentures to the amount of £50,000, in about six months' time. A dividend of 10 per cent. on the preference shares will be guaranteed for the first year by the Foreign and Colonial Elmore Company.

The increase of capital is required to complete the payment for the works, which have been erected on a scale of a "300-ton output" instead of 80, and to provide the additional working capital which the contemplated additional output will require. To enable the shareholders to judge of the exceptional value of these preference shares, the directors give a tabular statement showing a 15 per cent. dividend—if M. Secrétan's estimate, upon which alone these figures are based, is verified. At the last meeting, M. Secrétan stated confidently that the works would be in operation on July 1st last year. From his report now presented, it appears that they are only now finished; no orders have been executed, and no details are vouchsafed to enable anyone to judge that the figures quoted by the directors as showing the value of the new shares are other than mere imagination.

As a part of this new issue is to be offered to the public, we think it well to summarise the balance sheet, so that they may form a more reliable estimate of the value of the shares.

The company has received £283,806 8s. 2d., and has spent £326,909 17s. 9d. It owes to sundry creditors £49,279 0s. 7d.; against which indebtedness it has £6,114 12s., of which £5,742 1s. 8d. is cash, and £372 10s. 4d. is represented by "sundry debtors."

Of the amount received £232,898 6s. is from shareholders, and £50,000 from debentures, which have a first charge on the company's property; £226 10s. from transfer fees; and £681 12s. 2d. interest.

Of the amount disbursed, £183,375 has been paid for patents; £110,964 12s. 9d. for land, buildings, plant, machinery, furniture, &c.; £14,832 17s. 3d. for copper materials, &c.; £3,017 8s. 1d. for experiments; £12,662 3s. 6d. for administration; and £2,057 16s. 2d. for debenture interest.

It will be seen that of the £332,177 6s. 7d. which the shareholders have furnished, borrowed, or owe, £125,797 10s. only is represented by such tangible assets as land, buildings, plant, machinery, furniture and materials, and £5,742 1s. 8d. in cash.

No further progress is reported in actual work, but the directors appeal for fresh capital. No details can be given of commercial prospects on a commercial basis, but this is amply atoned for by the greater freedom and the more important figures which can be conjured up by the imagination. It is very easy for M. Secrétan to "contemplate"

being "overwhelmed with orders," and to imagine a revenue; but it is surprising that the secretary of the company should state, by order of the board, that the preference shares will be seen to be "secured" upon a revenue many times the amount required, when the revenue has no foundation in fact, and no information is given to justify its being considered even reasonably possible.

On January 16th, 1891, we wrote:—"The shareholders of the French Company do not need energy in the establishment of a factory which absorbs their money. What they do need is the exercise of judgment which will keep the money until they can see that an English factory pays." There is everything in the accounts now presented to confirm that opinion. The shareholders may decide, on the contrary, that it is desirable to expend still more money, and so to increase the capital, as proposed. If they do, the public will be wise not to be misled by the attractive figures placed before them. They will doubtless see that there is no "security" for such an issue, inasmuch as there is no present business upon which to make a calculation for the future, whilst the "security" at present existing is sufficiently demonstrated by the figures we have given above. And they may be further assured that none of the information now, or recently given, of the development of Elmore works shows such technical results as will justify estimates being formed on any other than a commercial basis.

LEGAL.

Love v. St. James and Pall Mall Electric Company, Limited.—The motion to restrain the above company from interfering with the plaintiff's ancient lights in the erection of their new central station, Carnaby Street, came again before Mr. Justice Stirling on the 13th inst.

Mr. Graham Hastings, Q.C., for the plaintiff said that since the application was made, the defendants had altered their plans, and although there was still something objectionable, yet if the defendants would give an undertaking to build only in accordance with these new plans, he would allow the matter to stand over till next motion day.

Mr. Buckley, Q.C., for the company, said he should have thought that the alteration of the plans would have finished it. The matter stood thus: On April 1st the defendants wrote and told the plaintiff that they were going to alter the plans as now proposed; and, notwithstanding that, on April 2nd the plaintiff sent the notice of motion. He was willing to give the undertaking now asked, not to build to a greater height than was shown on the new plans without prejudice to any question. He hoped that the hearing of the motion would serve as the trial of the action.

His Lordship allowed the motion to stand over until next term.

BUSINESS NOTICES, &c.

The Electric Light in the City.—Since our last report we learn that several further installations are being carried out in the City. Messrs. Paterson and Cooper, of Westminster, are fitting up an installation on the premises of the Colonial Mutual Life Assurance office at 33, Cheapside.—The Electric Power and Traction Company, Limited, of Kentish Town, are fitting up an installation at their City offices in Old Broad Street.—The offices of Messrs. Hunt, Cox & Co., stock and share brokers in Threadneedle Street, are being fitted for the electric light by Mr. W. E. Ommanney, of 1, St. George's Place, Gloucester Road, S.W.—Messrs. Laing, Wharton and Down, of New Bond Street, are carrying out an installation at Jamaica Buildings, St. Michael's Alley, Leadenhall Street, and Messrs. Croggon & Co., of Upper Thames Street, are fitting up an installation in the premises of Mr. H. J. Nickoll, tailor, Leadenhall Street.

Tenders Wanted.—Woolwich.—Tenders are invited by the directors of the Woolwich District Electric Lighting Company, Limited, for the supply and erection of the necessary machinery, &c., for a 1,000-light central station, and for providing and laying underground mains. Further particulars will be found amongst our advertisements.

Tenders Wanted.—Spain.—The General Direction of the Posts and Telegraphs of Spain, Calle de Carretas 10 Madrid, are inviting tenders until May 5th for the supply of 2 tons of 1 mm. bronze wire for telephones, 16 tons 1·6 mm. bronze wire, 2 tons 2 mm. bronze wire, and 25 tons 3 mm. bronze wire for telegraph lines.

Catalogues.—In our issue of last week, we stated that we had received a copy of a telephone catalogue from the General Electric Power and Traction Company. This should have read as coming from the General Electric Company, Limited. We much regret the error.

CITY NOTES.

The Indo-European Telegraph Company, Limited.

The directors' report for 1891 states that the company's revenue from all sources for 1891 amounted to £116,699 3s. 1d. as compared with £113,807 3s. 11d. for 1890, showing an increase of £2,891 19s. 2d. The expenses were: on commercial and general account £30,581 5s. 3d.; on maintenance account £30,527 7s. 7d.; total £61,108 12s. 10d., as against £57,901 19s. 7d. for 1890, an increase of £3,206 13s. 3d. Deducting the above expenses, taking credit for £4,168 16s. 7d. brought over from 1890, and debiting income tax, there remains the sum of £58,483 15s. 4d. From this amount £10,000 has been placed to reserve, and that sum, together with £10,625 amount of interim dividend, have to be deducted, leaving a balance of £37,858 15s. 4d. The directors now propose the declaration of a dividend for the six months ending December 31st, of 17s. 6d. per share, making, with the dividend already paid, 6 per cent. for the year and a bonus of 20s. per share, both free of income tax, making in all 10 per cent., carrying forward £5,983 15s. 4d. to the credit of 1892. The new rules, regulations, and tariffs of the International Telegraph Convention settled at Paris, have had full effect since July 1st last, but, as anticipated, have had no material influence upon the company's revenue. The arrangement with certain of the Australian colonies for the introduction of a greatly reduced tariff between Europe and Australia came into force on May 1st last. It will be remembered that Queensland and New Zealand decided to remain outside the above arrangement. The outcome of the reduced rate, so far, has been an increased traffic, coupled with a diminished receipt. On the whole, however, the results have been sufficiently promising to induce the governments and companies concerned to continue the experiment for at least another twelve months. The following directors retire by rotation, and offer themselves for re-election:—H. Weaver, Esq., and L. Delbrück, Esq. Holders of shares to bearer must deposit their shares, with name and address, at the office of the company, 48 hours before the time appointed for the meeting, against an order of admission. The share warrants will be returned after the meeting. The transfer books will be closed from the 13th to the 27th inst., both inclusive. The auditors, Messrs. C. F. Kemp, Ford & Co., public accountants, retire and offer themselves for re-election.

Elmore's French Patent Copper Depositing Company, Limited.

The following is a copy of the directors' first annual report and accounts:—

"Your directors beg to submit the annexed statement of accounts for the period from the date of the company's formation on September 6th, 1890, to December 31st, 1891. These accounts deal only with capital expenditure, as no trading was carried on during the period under report. They show the outlay that has been incurred on the company's factory at Dives, including the purchase of raw material, copper, coal, &c., and in the preliminary experiments and arrangements for the commencement of manufacture. The following circular, which gives full information of the position and prospects of the company, explains the object of an extraordinary resolution which will be submitted to the shareholders after the adoption of the report and accounts. The retiring directors on this occasion, Messrs. E. J. Carson and W. Elmore, being eligible, offer themselves for re election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., offer themselves for re-election.

Balance Sheet, December 31st, 1891.

Dr.	£	s.	d.
To Share Capital Authorised—			
100,000 shares of £2 each	200,000	0	0
„ Share Capital Issued—			
33,250 shares of £2 each allotted to the vendor company in part payment ... £66,500 0 0			
66,750 shares of £2 each subscribed 133,500 0 0			
100,000 200,000 0 0			
Less calls in arrear 484 14 0			
	199,515	6	0
„ Premium on 66,750 shares ...	33,375	0	0
„ Six per cent. mortgage debenture stock, redeemable in November, 1893, at 5 per cent premium ...	50,000	0	0
„ Deposits on shares forfeited	8	0	0
„ Sundry Creditors for Outlay on Works—			
In Paris, open accounts 18,344 19 6			
In London, bills payable ... 9,000 0 0			
In Paris „ „ 18,694 7 0			
	46,039	6	6
„ Sundry creditors in London ...	3,239	14	1
	£332,177	6	7

Note.—There are liabilities under contracts running for unfinished work in connection with the construction and equipment of the factory.

Cr.			£	s.	d.
By Cost of patents (including premiums on shares issued)			183,375	0	0
„ 37¼ acres of land at Dives and cost of acquisition			6,466	3	9
„ 6 acres of land at Bellegarde			5,270	0	0
„ Buildings and general works (including workmen's dwellings)			28,757	1	9
„ Plant, machinery, tools, &c.			64,402	18	4
„ Railway siding			1,390	5	11
„ Payments to contractors on account of work done			3,259	10	2
„ Stock of copper, materials, &c.			14,832	17	3
„ Office furniture and fittings in Paris and at Dives			1,085	8	6
„ Fittings of retail shop to supply workmen			333	4	4
„ Sundry Debtors—In Paris	£149	4 4			
In London	223	6 0			
			372	10	4
„ Cash—In Paris and at Dives	5,373	14 2			
In London	368	7 6			
			5,742	1	8
			315,287	2	0
„ Experimental Work—					
In Paris laboratories and at Dives	2,913	18 1			
In London	103	10 0			
			3,017	8	1
„ Establishment charges at Dives—salaries and allowances, stationery, fire insurance, and sundry expenses	2,326	5 6			
„ Establishment charges in Paris—travelling, plans, fittings of offices, legal charges, and sundry expenses	858	8 7			
„ General administration charges in Paris—fees of local committee, salaries of general manager and staff, rent, stationery, travelling, postages and telegrams, and sundry expenses	4,928	1 1			
			8,112	15	2
„ General Administration Charges in London—					
Directors' fees	2,125	0 0			
Salaries	963	14 11			
Law charges	345	4 0			
Travelling	299	11 1			
Patent renewals	169	2 0			
Rent, rates, taxes, printing and stationery, postages and telegrams, and sundry office expenses	646	16 4			
	4,549	8 4			
Less transfer fees	226	10 0			
			4,322	18	4
„ Debenture interest to December 31st, 1891	£2,057	16 2			
Less interest received from deposits, &c., in London and in Paris	681	12 2			
			1,376	4	0
Exchange difference			60	19	0
			£332,177	6	7

Examined with the books and vouchers in London and Paris, and with the certified returns from the works at Dives, and found correct.

(Signed) DELOITTE, DEVER, GRIFFITHS & Co.,
Chartered Accountants, Auditors.

4, Lothbury, *March 16th*, 1892.

At the meeting which is to be held to-day (Friday), the following extraordinary resolution for increasing the capital of the company will be proposed:—

"That the capital of the company be increased to £400,000 by the creation of 100,000 new shares of £2 each. Such new shares shall be called 'preference shares,' and shall be entitled to priority on a distribution of assets, and shall also be entitled, out of the profits available for distribution in each year, to a preferential dividend of 10 per cent. and to a further dividend of 5 per cent. after a dividend of 15 per cent. has been paid on the existing shares of the company, which shall in future be called 'ordinary shares.'"

The following is a copy of a circular issued with the directors' report:—

Translation of M. Secretan's (General Manager) Report, dated April 1st, 1892.

Gentlemen,—I beg to place before you the position of your company in France at the present time. I have the satisfaction to inform you that after long delays caused by cases of "force majeure" by numerous studies, by multiplied experiments, and also by the necessity of adapting the different mechanisms of the Elmore process to the special requirements of French demands, the factory is entirely finished, and the final modifications brought to bear on the material first provided for, are definitely realised. We have now 120 tanks actually ready to commence regular working for the manufacture of the ordinary tubes of commerce, and 144 large tanks also ready for the manufacture of sheet copper and wire. Up to the present, on account of the large programme which we set ourselves, we believed that, for various reasons and in order to avoid any misfortune, we should not accept firm orders, making an exception, however, in the case of a few of these orders, in consequence of the interest which they present for your company. One of these orders, especially destined for the French Navy, will be delivered during the first fortnight in April. I do not hesitate to inform you that its reception will demonstrate the superiority of our productions. I am to-day informing the commercial and industrial firms in France that we have definitely commenced normal and regular manufacture, and I am soliciting orders promised me in advance by the largest firms in this country. From now to April 15th next at latest we shall have at least 80 tanks containing 400 mandrels in full work, producing at least 100 tubes a day, of which the disposal is assured. I have much satisfaction in announcing that after our persevering efforts, all the products which we are now beginning to deliver, and shall continue to deliver each day, will answer in all respects to the programme intended to be followed of a perfect and regular manufacture. Regarding the value of our work, if you think that additional testimony to my own should be produced, you have in your hands the strong and flattering attestations of the firms:—Gueldry, Brimault and Tillier, Fel, and also of the old-established firm of Cail; and lastly, I propose to obtain other testimonials from the most important houses in this country. If this does not appear enough, in order to reply still more completely to all the criticisms that may arise, I propose also to open the doors of the factory at Dives to all the honourable and competent experts in France, in order to show them the truth of my assertions by placing before them our manufactures just as they come from the tanks, as well as the mechanical work, the most difficult which copper can be put to. Also it would give me pleasure, if you would on your side invite the most competent consumers and experts in England, to see the results obtained. The most sceptical will thus be forced to give way to evidence, and this demonstration will be more convincing than words. In addition to this undeniable proof of our excellent manufactures, I have the satisfaction to inform you, and the experts will be able to see it themselves, that not only will the cost price as at first announced not be surpassed, but, thanks to improvements I have been able to bring about, this price will be notably decreased. The presumed profits which I indicated to you as being possible to be realised with the projected issue of 3,000,000 francs will amount to a figure very close to 1,400,000 francs. There is no doubt whatever that the 300 tons which we can produce with the actual organisation of the factory at Dives will be easily absorbed by the current demand, and in a short time we shall be overwhelmed with new orders. We have seen from the commencement that an increase of plant to cope with such an increase of orders would be necessary. If you are of opinion that such an increase ought to be made without delay, I would propose to apply it exclusively to the manufacture of tubes of a small and of a medium size, which are required every day. Herewith I subjoin the results to be obtained with a further capital of 3,000,000 francs, making the new issue to 6,000,000 francs. We can then turn out 250 tons a month more, or a total of 3,000 tons a year, bringing an average profit of 80 francs per 100 kilos., or, in other words, the new 3,000,000 francs would produce a profit of 2,400,000 francs (£96,000). This large profit, derived from comparatively small additional capital, is explained by the fact that the 3,000,000 francs would be entirely devoted to a special manufacture, the most profitable in the copper trade, which would not moreover be handicapped with anything for the purchase of land, administration expenses, sidings, foundry, laboratory, and especially of patents. The reason why we have not established the Dives works exclusively for small and medium tubes is because it would have been impossible to ensure meeting all the current demands of the trade, if we did not commence by also producing sheet copper, tubes, and wire. Now having to-day the means of making sheet and wire, which bring in less, while at the same time we make a certain quantity of tubes which return more profit, we are in a position to satisfy the requirements of the principal trade. Annexed are schedules showing the several profits resulting from the comparative outlay of 3,000,000 francs or 6,000,000 francs. With an issue of 3,000,000 francs our profits amount to 1,395,000 francs (£56,000), and with an issue of 6,000,000 francs to 3,795,000 francs (£151,800). Regarding the disposal of a total production of 6,600 tons annually, there is no necessity for any fear, seeing that the production in France amounts to 18,000 tons a year, and that new sources of consumption daily arise. It is for you, gentlemen, as well as the shareholders, to determine which of these two capitals should be adopted for the new issue.

Accept, &c., &c.,

(Signed) E. SECRETAN,
General Manager.

Copy of Circular Letter to the Shareholders by the Directors.

You were informed by your chairman, in a letter addressed to you on January 1st last, of his impressions after visiting the company's works at Dives, near Havre, France, and that he had witnessed the commencement of the manufacture of the first tubes started in the works. Since that time great progress has been made towards completing the first portion of the works, so as to commence manufacturing on a commercial scale, namely, 300 tons per month, and the directors are pleased to be able to announce to the shareholders that they have received official information from M. Secrétan, the director-general, that this is accomplished, and that he is inviting all the leading copper users in France, together with the engineers of position, to visit the works after the 15th inst., and to see for themselves the remarkable quality of copper articles manufactured under the Elmore process. In the event of any shareholder desiring to inspect the

works, a card of admission to enable him to do so can be had on application at the office of the company; the directors believe that visitors will be greatly impressed with the extent of the works, the admirable way in which they have been fitted up, and the ease and simplicity of the manufacture. At the time when the services of M. Secrétan were secured, he impressed upon the board, who communicated his views to the shareholders, that it would be useless to attempt to embark in the business which the French Elmore Company was formed to carry on, unless the works were capable of turning out a minimum quantity of 300 tons per month, as the demand would very much exceed this quantity, and he knew that unless the company was in a position to supply all the various descriptions of articles that would be required, a large portion of the more remunerative part of the business would be lost. His willingness to take charge of the company's affairs in France was conditional on the establishment of works on this scale. As the shareholders are aware, at the time the company was formed, it was intended only to erect a plant capable of turning out 80 tons per month, and the capital of the company was framed on that basis. It is obvious, therefore, that the additional capital necessary to complete the payment for the more extensive works which have been erected, and to provide the additional working capital required, amounting to £120,000, should now be raised; indeed, but for the credit enjoyed by M. Secrétan with the contractors, that must have been done some time since; but the directors were desirous of not coming to the shareholders until they could inform them that the factory was completed on the above scale, and manufacture commenced. Accordingly they now call a meeting of the shareholders to authorise an increase of the capital of the company for the purpose above mentioned. In the circular of the directors, dated October 29th, 1890, they communicated the fact that M. Secrétan anticipated that the sales could easily reach 900 to 1,000 tons per month, and it will be observed in his last report, dated April 1st, 1892, that he contemplates in a short time being overwhelmed with orders, and urges that the output should be increased from 300 tons a month to 550 tons per month, equal to 6,600 tons per year. Seeing that the consumption in France amounts to 18,000 tons a year of copper tubes, plates, rollers, wire, and similar articles, there is no doubt, looking at the increased profits, that it is good policy for the company to adopt the suggestion to get the larger output at as early a date as possible. This will require a further sum of £120,000, making a total increased capital of £240,000. The mode by which this capital should be raised has occupied the attention of the directors for some time past; various plans suggested themselves, and after mature consideration, they have finally decided to raise it by increasing the existing £50,000 of debenture stock to £100,000, and by the issue of £200,000 of preference shares. The debenture stock will bear 6 per cent. interest, and the preference shares will be entitled to a preference dividend of 10 per cent., and, out of surplus profits, after the ordinary shares have received 15 per cent., to an extra 5 per cent., making a total of 15 per cent. Looking at the amount shown by M. Secrétan as earnable by the entire plant intended to be erected, it will at once be realised that the preference shares to be created will be an unusually solid and exceptional investment. With a view to furnish all the information possible, the directors called on M. Secrétan for a report of the earning power of the plant when so completed. This report states that the profits of the factory would amount to £151,800 per annum, and it is so important and interesting, that the directors give a verbatim copy for the shareholders' information. The directors have pleasure in stating that M. Secrétan reports that his original estimate of the cost of production has already been verified by actual manufacture, and that he is of opinion that this will be materially reduced in future. As regards the prices to be realised, the estimate submitted by M. Secrétan has been based on the sale price of ordinary articles of commerce, and mostly of the cheapest description, no credit being taken for any extra prices which will undoubtedly be realised on account of the superior quality of our manufactures, nor for those more expensive and remunerative articles, for the economical manufacture of which the Elmore process is specially adapted. The directors are convinced, from independent enquiry, that the average price taken in this estimate will be exceeded, with a consequent augmentation of the large profits referred to. Of the new capital, the directors propose to issue at once 60,000 preference shares of £2 each, and the remainder with the debenture stock in about six months' time, when it is anticipated that the existing works will be fully occupied. To enable the shareholders to judge of the exceptional value of the preference shares now to be created, a tabular statement is given at the end hereof, showing the result to both classes of shares—the preference and the ordinary. It will be seen that the preference shares will be secured upon a revenue many times the amount required, whilst the existing ordinary shares will benefit by reason of there being no augmentation of them. It is intended to offer 40,000 of the preference shares now to be issued, being two-thirds of the number, exclusively to the present shareholders in the proportion of two preference shares for each five ordinary shares standing in their names on the share register on the 22nd instant, and the remaining one-third, namely, 20,000 preference shares, will be offered to the general public, it being thought by the directors desirable to have the support of many persons interested in the copper trade, who in all probability may desire to subscribe. The directors have considered that it may be to the convenience of some shareholders to pay their instalments over a considerable period, and they have accordingly made them payable over a period of six months. The directors, however, will reserve to those who wish to pay in advance of the due dates, power to do so, in which case they will receive the guaranteed dividend referred to below, from the dates of payments of such instalments. One feature of the issue will doubtless be satisfactory to the shareholders, namely, that Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, who formed this company, desiring to aid it in every way, have engaged to guarantee the payment for the first year of a minimum dividend of 10 per cent. upon the present issue of preference shares, so that the subscribers may be in receipt of an income from the date of the payment of the shares. That company and your directors do not anticipate that this guarantee will be at all required, but your directors think it right to acknowledge the liberality with which the Foreign and Colonial Company, without payment, have complied with the request made to them thus to co-operate with your directors in giving the shareholders every advantage that the prosperous circumstances of this company amply justify. Finally the directors, in announcing the arrangements made for the advantage of the shareholders, trust they will appreciate the foresight shown by your board in having laid out the works on a scale sufficiently large to cope with the demand which has been proved to exist for the company's manufactures, thus establishing for the company the prestige so necessary for obtaining large and important contracts.

Table showing Division of Profits based on M. Secrétan's Estimate, with an output of 550 tons per month, upon a Capital of £100,000 6 per cent. Debentures, £200,000 Preference Shares, and £200,000 Ordinary Shares.

Amount of annual profit, as per M. Secrétan's report (3,795,000 francs)	£151,800
Less French officials' proportion of commission on profits and London expenses	31,560
Annual net profit	£120,240
Less interest on £100,000 6 per cent. debenture stock	6,000
	£114,240
Less 10 per cent. dividend on £200,000 preference shares	20,000
	94,240
Less 15 per cent. dividend on 200,000 ordinary shares	30,000
	64,240
Less 5 per cent. extra on above preference shares, making 15 per cent.	10,000
	£54,240
Less 5 per cent. extra on above ordinary shares, making 20 per cent.	10,000
Surplus	£44,240

The surplus being available for extra dividend and reserve fund, or other purposes as may be agreed upon by the shareholders in general meeting.

Summary.

Dividend of 15 per cent. on £200,000 preference shares	£30,000
Dividend of 20 per cent. on £200,000 ordinary shares	40,000
Surplus	44,240
	£114,240

Great Northern Telegraph Company of Copenhagen.

The directors' report just issued shows the traffic receipts, together with balance on December 31st, 1890, and sundries, amount to £359,646 3s. 1d. Under the head of expenditure, salaries and wages are given at £41,123 10s.; expenses of stations, offices and agencies, £8,728 10s. 8d.; supervision and maintenance of lines and repairing steamers, £9,919 1s. 4d.; instruments and cells, £775 16s. 11d.; maintenance of buildings, £576 15s. 4d.; travelling expenses, £446 6s. 8d.; bank commission, &c., £3,411 0s. 1d.; and sundries £467 7s.; 5 per cent. interest on debentures and amortisation of 100 debentures amounts to £21,250. The surplus amount is proposed to be appropriated as follows:—Interim dividend paid on 150,000 shares at 5 per cent. £75,000, and extra dividend of 7s. 2d. on 150,000 shares £54,166 13s. 4d.; addition to the reserve and renewal fund £33,333 6s. 8d.; addition to the pension fund of the staff £2,777 15s. 7d.; directors' remuneration £1,500; balance carried forward £56,169 19s. 6d.

Electrical Automatic Delivery Box Company.—Mr. F. G. Painter (of the firm of Tribe, Clarke, Painter and Co.), official liquidator of the Electrical Automatic Delivery Box Company, will, with the sanction of Mr. Justice Kekewich, pay a first and final dividend of 1s. 8¼d. per share on and after the 19th inst. at his offices, 19, Coleman Street, E.C. The creditors have been previously paid 20s. in the pound.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 15th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, amounted to £2,746.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation, April 13th.	Closing Quotation, April 21st.	Business done during week ending April 21st, 1892. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 — 103	100 —103	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	48½— 49½xd	48½— 49½xd	...	...
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	87½— 88½xd	87½— 88½xd	88½	87⅞
2,849,510*l*	Do. do. Deferred	Stock	11¼— 11⅝	11 — 11⅛	11¼	...
130,000	Brazilian Submarine Telegraph, Limited	10	10¾— 11¼	10⅞— 11¼	11⅛	10 13/16
53,200*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —108	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3¼	3 — 3¼	...	...
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2¼	2 — 2¼	2¼	...
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½— 4½	3½— 4½	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½— 3½	2½— 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	7½— 8	7½— 8	...	...
$7,716,000	Commercial Cable, Capital Stock	$100	155 —160	155 —160	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅜— ½	⅜— ½	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5⅛— 5⅜	5⅛— 5⅜	5⅜	5⅛
16,000	Cuba Telegraph, Limited	10	10½— 11½	10½— 11½	...	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3⅛— 3⅜	3⅛— 3⅜	...	...
6,000	Do. do. 10 p. c. Preference	5	8½— 9½	8½— 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅛— 11⅜xd	11⅛— 11⅜xd	11½	11⅛
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 14⅝xd	14⅜— 14⅝xd	14⅞	14⅜
70,000	Do. 6 p. c. Preference	10	15 — 15½xd	15 — 15½xd	15 5/16	15⅛
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109	106 —109	107	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	109 — 112	109 —112	...	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15¼	15¼	15
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	104⅝	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	108 —111	108 —111	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —102	99 —102	100½	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5⅝— 6¼	5⅝— 6¼	6¼	5⅞
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅜— 1⅝	1⅜— 1⅝	1⅝	1⅜
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅜— 2⅝	2⅜— 2⅝	2⅝	2⅜
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅜— 1⅝	1⅜— 1⅝	1⅝	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10 — 10¼	10 — 10¼xd	10 5/16	10
180,042	Do. do. 6 p. c. Preference	10	15 — 15½xd	15 — 15½xd	15½	15
150,000	Great Northern Tel. Company of Copenhagen	10	18¾— 19¼	18¾— 19¼	19¼	18⅞
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7⅞— 8⅛	7⅞— 8⅛	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10⅛	9½— 10⅛	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	19½— 20½	19⅝— 20½	20½	20¼
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —105	102 —105	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	42½	42⅜
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	4½— 5½	4½— 5½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	2⅞— 3	2⅞— 3	3	2⅞
10,000	Do. do. fully paid	5	5 — 5⅛	5 — 5⅛	5 1/16	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	8¼— 8⅜	8¼— 8⅜	...	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅛— 4⅜	4⅛— 4⅜	4⅜	4⅛
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½— 13½	12½— 13½	13½	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12 — 12½	12 — 12½	12½	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	107 —109	106 —108	...	...
250,000*l*	Do. (issued at 5 p.m., all paid)	...	79 — 81	104 — 106	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4½— 5½	4½— 5½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼— ⅜	¼— ⅜	...	...
9,000	Reuter's Limited	8	6 — 7	6 — 7	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8¼— 8⅜	8¼— 8⅜	8⅛	8 1/16
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7½— 8	7½— 8	7 15/16	7 13/16
3,381	Submarine Cables Trust	Cert.	116 —121	115 —120	117	115½
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3⅞— 4¼	3⅞— 4¼	4⅛	4
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43½	...
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2 — 3	2 — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	101½	...
30,000	West Coast of America Telegraph, Limited	10	3½— 4½	2½— 3½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	102 —106	...	...
67,007	Western and Brazilian Telegraph, Limited	15	10 — 10½	10 — 10½	10⅜	...
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6⅜	...
30,364	Do. do. do. 5 p. c. Deferred	7½	4 — 4½	4 — 4½	4	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	104 —107	104 —107	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	104 —107	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅝— 1⅞	1⅝— 1⅞	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10 7/16	10
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9 — 10	9 — 10	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	99 — 103	99 —103	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	97 —100	98 —102	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6½— 7	6½— 7	6⅝	6⅜

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7½—7⅝.—Electric and General Investment, shares of £5 (£1 paid), 2—2⅛.—Founders' shares, 150—200.—Elmore Foreign and Colonial Copper, Founders' shares, 6½—7½.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable, 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2½—3½.—7 per cent. Preference Shares of £5 (fully paid) 5⅛—5⅜.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅞—6, 1st Preference Cumulative 6 per cent., £5 (fullypaid), 5⅞—6.—Liverpool Electric Supply Shares of £5 (fully paid), 5—5⅛.—Do. shares of £5 (£3 paid), 2⅝—2¾.—London Electric Supply Corporation, Ordinary (£5 paid), ⅞—1⅛.—Do. 6 per cent. Preference, 1½—1⅝.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅜—⅝.—Metropolitan Electric Supply Company, Founders' Shares, 300—400.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—½.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—¼.—Do. Debentures, 103—¼.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—¼.—£5 Preference (fully paid), 2¼—2⅜.—Ward's Electric Car (£10 paid), 1⅜—1⅝.

Bank Rate of Discount.—2½ per cent. (April 7th, 1892).

ELECTRICITY IN ITS RELATION TO MINING.

By ERNEST SCOTT.

No. III.

(*Concluded from page* 478.)

Electric Locomotive.

In electric locomotives for mining, the overhead wire system, which has been so extensively adopted in America, and has quite recently been tried in Leeds, is perhaps the best, the connection being made by a rubbing contact, or through the wheels of a little trolley running on the wire. The locomotive is fitted with reversing levers, so that it can either pull or push the tubs.

It is surprising how very compact the machine can be made, a 15 H.P. Sprague locomotive for an 18-inch gauge is 2 feet 6 inches × 2 feet 6 inches × 5 feet 2 inches long, and weighs less than two tons. They can be used in places inaccessible to the pit pony, the height of the driver's head from the floor, when he is in a sitting position on the car, does not exceed 3 feet 6 inches.

We cannot hope for high efficiencies with these machines in mines, seeing the severe conditions under which they will have to work steep grades, sharp curves, in contracted spaces, and on rough roads. But in underground workings, when the fouling of the air by steam and smoke is very objectionable, or in coal mines, entirely out of the question, there is no doubt an extensive field for electric traction.

The General Electric Power and Traction Company have built an electric locomotive to take the place of five horses on a road of 500 yards long, in the Wharncliffe Silkstone Collieries, the incline being 4 inches to the yard. The machine got a direct pull on a rope which is fixed at either end and lies parallel to the rails. The rope is passed round a wheel geared to the motor, the current being supplied by an overhead wire.

Coal Cutters.

Broadly speaking, in the United Kingdom these may be divided into two classes, those with wheel cutters in which the tools are fixed to the periphery of a disc, and which bring out the cuttings direct, and the bar cutters, which have the tools fixed in the form of a three or four threaded screw, the cuttings being either drawn endways by the screw or fall back into the space behind which has been cut. They are less liable to be held fast by a fall of coal, and will cut to a greater depth without jamming than the wheel cutter, and the blunt cutter tools can be easier rep'aced.

A bar cutter machine, built by Messrs. Goolden and Company, running at 500 revolutions per minute, will undercut on an average 20 or 30 square yards of hard coal in one hour, including stoppages. At Lord St. Oswald's Colliery, Nostell, as much as 54 square yards were undercut in one hour, or about 43 yards to an average depth of 3 feet 8 inches.

The machine is mounted on wheels laid alongside the face of the coal, the cutter bar is then turned through an angle of 90°, cutting its way into the coal. It is here locked, and the whole machine is then drawn along, either by hand, with winch and wire rope, or automatically by small hauling gear fixed on the front of the machine.

The cutter tools in the bar are arranged so that grooves are cut in the coaly shale about $\frac{3}{16}$ inch deep, and then the intervening pieces are split off, and in this way more power is saved than if all the material was to be cut.

When the tools are blunt the cutter bar is removed and a new one put in. The blunt tools are driven out and taken to the bank to be ground up on an emery wheel. The motors are enclosed, as the machines are likely at any moment to strike blowers.

All the gearing is also enclosed to keep out dirt and dust.

The average production of coal per *employé* in the Pennsylvania coal fields is more than 1½ times the amount raised by the average English or Scotch colliers, and the *Colliery Guardian*, August 28th, 1891, suggests that this may be due to the greater average depth of the seams and to the large amount of coal-cutting machinery employed. It may be interesting, therefore, to note one or two of the machines made in that country.

The Jeffrey Electric Coal Cutting machine consists of a bed-plate 2 feet wide by 8 feet 6 inches long, composed of two steel channel bars, firmly braced, the top plates on each being racks with their teeth downwards, into which the feed wheels of the sliding frame engage. Mounted on this bed frame is a sliding frame, similarly braced, consisting mainly of two bars, mounted on the rear ends of which is an electric motor. The power is transmitted through straight gear and worm wheel to the rack. On the front of sliding frame is mounted the cutter bar, held firmly by two solid shoes. The cutter bar contains steel bits, and when running the cutters cover the entire face. The cutter bar is revolved by an endless link chain from the driving shaft. The motor will develop 15 H.P. and cut 5 feet into the coal. It is moved forward about 42 inches at a time, and the makers say it will do 6 cuts, or about 12 square yards, in an hour in hard coal.

One of the Van Depoele Coal Mining Machines or borers consists of a series of drills placed side by side and driven through pinion gearing by an electric motor fixed in the rear of the machine. It is fed forward by two screws at the back, and is provided with an apron and scrapers underneath to clear away the borings.

Messrs. Goolden & Co. are now building for the Woodfield Syndicate coal-cuttting machines of improved design, the "Turn-table," which can be arranged to cut either right or left hand, carries part of the gearing and the cutter bar. It is detachable from the motor part of the machine, and can be run along on wheels by itself. All the principal parts, including the magnets, are of cast-steel, so that there is a maximum of strength in the space taken up. It is arranged to pull itself along the roadway. The motor takes about 12 H.P.

Mr. Ravenshaw found, by employing steel having a large amount of hysteresis, that when the machine is put on open circuit the speed is much lower than if the machine had been built with wrought-iron field magnets.

Constructional Details of Dynamos and Motors.

The motor should be built to work under severe conditions. There should be no delicate mechanism, as they will be handled by men who know nothing of delicate adjustments, and they should be designed large enough so as not to have to do an excessive amount of work, and then with proper care sparking at the commutator will not take place.

The armoured method of armature building is to wind the wire into deep notches on the periphery of the core, and then cover with a layer of annealed iron wire. In this way the air space and copper in the field magnets can be reduced, and the armature can be roughly handled and laid on the ground without receiving injury.

The Gramme form of armature is the best for mining work, the wire being positively driven by numerous fibre keys let into the periphery, and the wire is wound in tight. By this means any movement which would in time chafe off the insulation and cause a short circuit is effectually prevented.

Amongst the forms of magnets most often used, the single coil form, with cast-iron pieces, is perhaps the simplest. The single horse-shoe with two magnet coils is very often used; but the Manchester type adjusts itself best to mining machinery. It lies very squat in the bearings, being low down, and is very suitable where there is little head room. The one with the four magnet coils is peculiar to the Crompton machines, and the multipolar shape is best suited for machines of 100 or 200 or more H.P.

All surfaces where there is a likelihood of leakage should be insulated with mica, as it is practically the only insulation to be depended upon. It is also advantageous to cover fibre surfaces with mica.

Copper plated carbons are now coming into use as collectors. Being pressed on to the commutator in a radial direction, they are admirably adapted for motors where the direction of rotation is reversed occasionally.

Where the direction is in one constant direction, as with dynamos, it is found advantageous not to cut the brushes square at the ends, but at an angle of about 60°, and the machine being rotated so as to lift the brushes.

The noticeable feature about carbon brushes is that there is practically no lead, and in consequence the characteristic of

a shunt wound machine is considerably improved, the cross magnetisation being considerably decreased.

In the Electric Power and Traction Company's brush carrier and holder, the brushes are carried in an adjustable holder, and are pressed on to the commutator by spiral springs at the back. This company also make a good many of their motors with double commutators, thus increasing the width of the sections, which are coupled up alternately. Messrs. Goolden's brush-holder has an adjustable barrel spring and finger which presses directly on the top of the brush, the connections being sweated on.

Several examples of the new motor were to be seen at Frankfort. They are worked on a system of alternate currents of several phases called Drehstrom.

The currents are led to the magnets which are stationary; the rotary current revolves as it were, and induces the current on the armature which need have no connections.

The principal objection that has been raised is that it does not exert torque at starting. A three-phaser at work in the Frankfort Exhibition, which may be taken as the latest and most improved of its kind, was at work driving a rotary pump, which, of course, gave it a good chance to get up its speed before doing any work.

The torque of the three-phaser only amounts to 1·6 of the normal torque, the collector (not commutator), and the brushes of this machine were for the purpose of putting in some resistance which would decrease the cross magnetisation. As soon as the machine has got fairly going the brushes are not required, there is no sparking. If a simple alternate current or multi-phaser motor can be made to work without brushes and collector, and to start with full load, there is no doubt a great future before it. We learn from the *Electrical Age* of New York that eight Michaelis coal-cutting machines, each fitted with a Tesla alternating current motor, have been set to work at Bunola, in America.

The great advantage of the system is that it lends itself so well to transformation, although it may be said on the other side that pressures above 800 volts would be out of the question in damp mines.

The series wound machines are very convenient for underground work, because in the event of the motor being stopped, there is no danger of receiving a shock in handling the cables or machinery, and also on account of being able to stop the machine easily and without spark. By putting a resistance of small self-induction across the ends of the dynamo field magnet coils, a path is provided for the current in the coils to discharge through when the main circuit is broken. The series machines are also very suitable for high voltage, requiring comparatively few turns of wire on the field magnets.

Shunt wound dynamos and motors have the advantage that the self-induction of the circuit is small, and the magnet coils have always the path of discharge through the armature, which is equivalent to a small self-induction resistance.

In order to prevent leakage or short circuit in the field magnet coils (the fall of potential, through which may be considerable), the wire should be wound in sections, between each of which is a sheet of fibre and mica.

Mr. Scott also shows the method of regulating the potential in a series wound dynamo. An adjustable resistance is put in the magnet circuit, and by moving the switch over the contacts, the exciting current can be adjusted to a nicety.

He also gives a method of starting a shunt motor slow. When the switch is moved from the "off" on to the first contact, the machine commences running; but owing to the resistance which is in the main circuit, the current through the armature is small, and it starts off slowly; the switch is then moved slowly over the other contacts, and the resistance cut out of the main circuit and put into the shunt circuit, where it has no effect, because the shunt windings have been made allowing for this resistance being in when running at the normal speed.

A shunt or compound wound dynamo on the bank, and a series wound motor in the pit, is a good arrangement; but the best arrangement in large installations is to have separately excited dynamos, an adjustable resistance being put in the exciting circuit.

Wiring.

The wires should be put up in such a manner as to be readily accessible.

With high potential circuits, say, 600 or 700 volts, it is necessary to use a high class insulated cable, especially in wet places. If the wires are laid underground, which is no doubt the best place to put them, they are provided with junction boxes at intervals. Old wire ropes should not be used; cheap, and what might be called economically reckless line work, leads to endless trouble. The use of a soldering iron is out of the question in most coal mines, but there are several efficient ways of making a joint without its aid.

A junction box or screw connection may be used, or a corrugated fitting, in which the two wires are laid side by side, and then twisted over each other several times. The taper ending fitting is very good. The wires having been pushed through the ends and out of the middle, they are then bent back on themselves and pulled tight, the intervening space being filled in; and again, the solder may be melted in a crucible by a small oil lamp, the flame being protected in the same way as with the wire gauze safety lamp.

The using of old wire ropes in collieries is very tempting, but the danger from short circuits is so much increased that it is unadvisable to bring them in. The current may, however, with safety be taken to the machine with an insulated cable, the return being made with a separate bare wire.

Lead covered cables seem to be very suitable in damp situations, and they should, as a rule, be used in the pit shaft, where it is also advisable to cover with wood casing so as to protect from falling stone. Armoured cables are now being made by the Fowler Waring Company, &c., which would require a very great stress to break them.

The size of the cables in electric transmission is an important item, forming as it does a good part of the total cost.

The wires necessary for any particular installation depend upon the distance and the loss due to the resistance which may be allowed. It is, however, usual for a distance of one to three miles to allow from 7 to 10 per cent. loss, but a great deal depends upon who is having the plant put down; one mine owner does not mind the efficiency being low so long as the first cost is not very great; another asks for efficiencies of 70 or 80 per cent., and of course has to pay for it at first, but reaps the advantage afterwards.

A moderate outlay, however, will give an efficiency of about 65 per cent., and this seems to suit most requirements.

Switches.

The switches which are required are enclosed in gas-tight covers. The following is a description of one made by Messrs. Goolden & Co. It is a double-pole switch, arranged for a series wound motor, has a number of contacts, between each pair of which are a series of increasing resistances, which carry the current as the switch is being slowly moved over the contacts. In this way the magnetising current is diminished until the series wound dynamo has ceased to excite itself, when the switch is put on to the magnet short circuit contact, and the main circuit broken without causing any spark.

There is really no reason why the switch should be in the mine at all; it might very well be on the bank, with a signalling apparatus between it and the motor; or it could be put in an intermediate position, nearer the pit shaft than the machine, so that in the event of the ordinary safety lamp giving signs of a sudden increase of gas, the men would be able in retiring to stop the machine. In the event of its being left, however, the gas would only be able to leak in very slowly, and the current would be shut off at the bank long before it became explosive.

It may be interesting to note another method of destroying sparking. It consists in breaking the circuit through several voltameters arranged in series, and containing faintly acidulated water; they are, in fact, large capacity condensers.

Tests.

First as to compressed air plant efficiencies.

In compressed air transmission it is found the heat waste is a minimum when the compression is performed isothermally.

Isothermal compression, it appears, is next to an impossibility. Prof. Elliott has, however, shown that by having multiple cylinder compression and intermediate cooling, the expansion line of the motor can be made to hug the

isothermal curve. He can therefore get a maximum economy by using triple and quadruple compressors and motors.

The following table was made out assuming a pressure of six atmospheres absolute, the losses being allowed on the same scale as Prof. Kennedy found them to exist in the Paris installation over a distance of four miles.

$$\frac{\text{I.H.P. of motor cylinder}}{\text{I.H.P. of steam cylinder compressor engine}}.$$

	Efficiency per cent.
Simple compressor and simple motor	39·1
Compound „ „	44·9
„ „ compound „	50·7
Triple „ triple „	55·3

Messrs. J. Fowler & Co.'s tests with compressed air gave efficiences $\left(\frac{\text{B.H.P. of motor}}{\text{I.H.P. of comp. engine}}\right)$ as 25·8 per cent. with 40 lbs. pressure, and 45·8 with 19 lbs. pressure.

Professor Kennedy's tests made in Paris, showed the efficiency $\left(\frac{\text{B.H.P. of motor}}{\text{B.H.P. of comp. engine}}\right)$ with a 10 H.P. motor was 31 per cent. if the air was not heated, and 45 per cent. if it was heated before passing into the motor.

In a series of tests made with 34 motors worked with compressed air, at Birmingham, with the pressure about 60 lbs. absolute, the air being used expansively, and in some cases heated, the average efficiency came out as 42·66 per cent.

All the above tests were made above ground, and in most cases the air was heated before being used in the motor. They are therefore, hardly comparable with following results of electrical transmission, which were made with the machinery *in situ*.

The losses in electrical transmission are in the dynamo and motor, and in the mains. The loss in the dynamos and motors, as they are now built, need not be more than 10 per cent.; in many of the larger machines of upwards of 50 H.P. efficiences of 93 and 95 per cent. can be got. The motor is generally not quite so efficient as the dynamo, more attention being given to strength and constructional details. The loss in the conductor need not be more than 10 per cent. or 12 per cent., but of course it can be almost anything, the practical limit in one direction being E.M.F., which must not be dangerous to life, and must be suited to the insulating materials which we at present know of; and in the other direction is limited by the cost and size of the conductor.

The statement therefore, one often hears "that it is best to wait for further developments," hardly applies, because the machinery cannot well be made more efficient.

It will be seen from the above that the total losses can be kept within 35 per cent., and plants are running where the losses are within 25 per cent.—that is to say, have an efficiency $\left(\frac{\text{B.H.P. of motor}}{\text{B.H.P. of generator}}\right)$ of 75 per cent.

A test made with the pumping plant in operation at the Trafalgar Colliery, where about 20 H.P. was transmitted a distance of nearly 2,000 yards, the efficiency showed nearly 40 per cent. This plant was put down about five years ago, belts being used to drive the pumps.

The efficiency $\left(\frac{\text{B.H.P. of motor}}{\text{I.H.P. of engine}}\right)$ of the pumping and hauling plants at St. John's Colliery, Normanton, when first tested, gave 43·1 per cent. This has now been increased, by putting in larger delivery pipes, to nearly 50 per cent., the compressed air system, which was replaced, giving an efficiency of only 14 per cent.

At the Llanerch Colliery, Monmouthshire, the hauling plant gives an efficiency $\left(\frac{\text{B.H.P. of motor}}{\text{I.H.P. of engine}}\right)$ of 48·5 per cent., the distance of transmission being about 1,000 yards, and the power about 26 H.P.

A test of a continuous hauling plant at the West Canock Collieries, Staffordshire, gave an efficiency $\left(\frac{\text{B.H.P. of motor}}{\text{B.H.P. of engine}}\right)$ of 71·3 per cent. The tests were made directly after the machinery was started. The road being in an incomplete condition, better results will no doubt be got when the machine has settled down to its work.

Messrs. Crompton & Co. have recently put down a main and tail hauling machine at the Abercanaird Colliery, South Wales. About 50 H.P. is transmitted a distance of 3,200 yards. Mr. Howell found the efficiency $\left(\frac{\text{B.H.P. of motor}}{\text{I.H.P. of generator}}\right)$ to be about 66 per cent., which means the efficiency $\left(\frac{\text{B.H.P. of motor}}{\text{B.H.P. of generator}}\right)$ will be more than 70 per cent. This plant replaces about 27 horses, and enables the output to be increased by 100 tons a day.

The tests of a pumping plant in operation at Allhallows Colliery, near Carlisle, where about 17 H.P. was transmitted a distance of 1,200 yards, shows an efficiency $\left(\frac{\text{B.H.P. of motor}}{\text{B.H.P. of generator}}\right)$ of 76·5 per cent. The power lost in the engine was a large proportion of the total, owing to the engine working with less than half its proper load. The efficiency will increase as the load increases, by the pump being put further down the dip.

A PRACTICAL DEMONSTRATION OF THE TRANSMISSION OF FORCE BY ELECTRICITY, MADE IN THE YEAR 1858 BY EUGENE REGNAULT.

By A. M. TANNER.

In a series of communications to the Electrical Review the writer has endeavoured to give the precise history of the transmission of force by electricity, and the electrical utilisation of natural forces. It has been shown that Jacobi, as early as the year 1850, stated that "every electro-magnetic machine could also be worked as a magneto-electric machine and *vice versâ*"; that Nollet in the year 1841 proposed the driving of magneto-electric machines by water or wind power; that Sinsteden in the year 1851 suggested the use of currents produced by magneto-electric machines for driving electric motors, and, finally, that Bessolo in the year 1855 clearly disclosed the electrical utilisation of natural forces, and the long distance transmission of electrical energy for power purposes.

There is no positive evidence to show that there ever was a reduction to practice in either of the instances above cited, and it therefore becomes of interest to establish the date of the first actual carrying out of the transmission of force by electricity.

From a communication in the French journal *La Science Pour Tous*, for March 18th, 1858, it appears that one, Eugene Regnault, actually worked a Froment electric motor by the current from a Clarke magneto-electric machine, driven itself by a mechanical motor. The following is a free translation of the communication in question, viz.:—

Application of Electricity as a Motive Force.

"I disclose to you the following use of electricity which I have recently made for motive power purposes. It has often been attempted to utilise this agent for replacing steam, but all scientists who have worked in this direction have consecrated their time to reach a common end, viz., to obtain a source of electricity of little cost. Many batteries have been invented without satisfying the necessary conditions, because in addition to their slight constancy, it was necessary to frequently renew the zincs and liquids, so as not to diminish the strength of the current, and all this entailed considerable cost. It has been mentioned for some time that currents could be produced by immersing the zincs and carbons in pure water; this system, it is true, might be suitable for use in factories, but when we consider the difficulties encountered in using a considerable number of elements for producing a current of the desired strength it is seen that this system is not adapted for certain mechanical purposes, such as railways, steamboats, &c. The question, however, of the use of electricity as a motive force appears to have been settled for a long time, because all the effects of voltaic currents can be produced even to a greater extent, by means of induced currents; and I can see no reason to prevent the employment of a Clarke machine as a source of electricity. It answers all the necessary conditions, and in comparison to batteries

takes up less space, and gives a stronger and more regular current, which can be easily varied by turning the crank of the electro-magnet (armature) with more or less speed. I have myself practically applied my invention in an oil mill, where the stone is turned by electricity according to the system proposed by Froment. But as it is tiresome to turn the magneto-electric machine by hand, I have adapted thereto a small mechanical motor, such as is used for turning meat spits, which operates as long as the oil mill is in action. I am of the opinion that my mode of applying electricity as a motive force will not be ignored, and that the experiments which I have made are of such a satisfactory nature as to cause my invention to be carried into general practice."

In explanation of the paragraph referring to a Froment electric motor for operating an oil mill, it is to be observed that such a combination was made generally known through the French International Exposition of 1855, and in fact several text books treating of the practical applications of electricity, illustrate the way in which a Froment motor operates the runner stone of an oil mill.

It is quite evident that Regnault did not intend to restrict himself to the use of the well known Clarke magneto-electric machine, and that he contemplated the use of any magneto electric generator, then known for furnishing the current for driving an electric motor. The selection of the Alliance Company's magneto-electric machine as a generator, and the use of a pole changing electric motor, would necessarily have led to better results than could be obtained by a Clarke generator and Froment motor; but so far as the invention and actual reduction to practice was concerned it made no difference how the mechanical energy was converted into electrical energy and then again transformed into mechanical energy. These three steps, the fundamental features of all systems of the transmission of force by electricity, were actually made use of by Regnault in the year 1858, and his work should not be ignored when the history of the subject is presented in text books more precise than any now out.

THE ELECTROMOTIVE FORCE OF GAS BATTERIES.

Some interesting measurements of the E.M.F. developed in gas batteries have recently been carried out by G. Markovsky, whose previous work in this direction has already attracted some attention. The elements used in the investigation consisted of platinum plates *completely* immersed in dilute sulphuric acid (which had previously been carefully boiled out, and was therefore free from gas), and plates of the same metal *partially* immersed in the same dilute acid, and at the same time partially exposed to atmospheres of pure oxygen and hydrogen.

Markovsky's account of this research occupies about 15 pages in the *Annalen der Physik und Chemie*: but his chief results may be very briefly summarised. He finds that the electromotive force of a platinum plate in hydrogen gas, against a similar plate immersed in dilute sulphuric acid, that has been previously boiled free from gas, is 0·646 volt. When, however, oxygen gas is substituted for hydrogen gas, the current is in the *opposite* direction: in this case the electromotive force is little more than half of the value when hydrogen is used, being measured as 0·372 volt.

It does not matter whether the hydrogen gas is prepared electrolytically from acidulated water, or from the decomposition of dilute sulphuric acid by means of granulated zinc, for, in either case, the same electromotive force is obtained when the gas is employed in the above elements. The same statement may be made of oxygen gas prepared either electrolytically or by any of the strictly chemical processes of manufacture. This rather upsets some previous observations.

Experiments were also carried out with elements in which the dilute sulphuric acid contained sulphate of platinum in varying quantities. From these experiments it appears that when sulphate of platinum is added to the dilute sulphuric acid, the electromotive force of an oxygen cell is diminished, whilst that of a hydrogen cell increases. Strange to say, however, the sum of the electromotive force in these two cases is the same as it is when sulphate of platinum is not used.

Markovsky made a number of observations in order to determine whether the electromotive force bears any relation to density and temperature, and he found that up to 70° Centigrade it is independent of these.

In one or two instances carbon electrodes were used instead of the platinum electrodes; these appear to behave quite differently.

AUSTRALIAN ELECTRICAL NOTES.

[from our own correspondent.]

The Corporation of the City of Adelaide are again prepared to receive tenders, "with full descriptive particulars," for the provision and erection of a complete installation for the electric lighting of the streets and public places of the city; but this time the conditions, &c., have undergone a considerable revision. Tenders are alternative. The number of lamps proposed to be provided for at present are 20 arc lamps of 1,000 candle-power, and 900 incandescent lamps of 32 candle-power. On the date that the installation starts running these are the numbers that will be required to be lit, but tenderers must provide for sufficient plant, steam power, &c., for the addition of 30 more 1,000 candle-power arc lamps, and 200 more 32 candle-power arc lamps to be distributed about the city, when and where the Council may decide to erect them, and it is further stated that the cables must also be of sufficient size to allow of this addition. Alternative tender A is to be to supply and erect a complete installation, including all boilers, engines, dynamos, poles, cables, conduits, lamps, and all other plant and materials necessary for lighting the streets according to the above requirements, and to work it for six months after completion, and then, of course, sell outright to the Council. Alternative B is as above, but the contractors are to run the lamps specified for 21 years; the Corporation to have the right at any time during the contract, or any extension thereof, to purchase the whole of the works and installation as a going concern, either with or without all or any patent or other rights appertaining thereto, or used in connection therewith, on giving to the contractor three calendar months' notice in writing of such intention, on payment to the contractor of the value thereof to be mutually agreed upon, or in case of difference, to be ascertained as follows, that is to say:—One arbitrator shall be appointed by the Corporation and one arbitrator by the contractor, and in all matters relating to such purchase shall be submitted to the decision of such arbitrators, and in all respects such arbitration shall be conducted in accordance with, and under and subject to the "Arbitration Act, 1891," or as near thereto as the circumstances of the case will admit. There is also the usual clause about right of purchase on termination of contract, the Corporation having the right to purchase on the day the contract terminates on giving to the contractor twelve calendar months' notice in writing of such intention, on payment to the contractor of the value to be mutually agreed upon or settled by arbitration, as in the preceding paragraph. If the Corporation does not wish to extend the contract or purchase the plant, it may give the contractor three calendar months' notice to evacuate.

In the event of the Corporation accepting a tender under Alternative A, payment will be made at the rate of 33 per cent. of the value of the works as erected and approved, and to the extent of 75 per cent. of the contract price within one month of the date that the installation shall be completed and successfully started, and the balance within one calendar month of the date that the whole installation shall be transferred to the Corporation in full working order, and to the complete satisfaction of the engineer to the Corporation. In the event of the acceptance by the Corporation of a tender under Alternative B, the payments will be made in equal monthly instalments within two weeks of the date of such instalments becoming due, the first instalment becoming due one calendar month from the date that the whole installation shall be successfully started to work, and such instalments shall be paid to the contractor until the completion of the term of the contract, less any penalties to which the contractor may have become liable. The penalties to which the contractor shall be subject under this clause are 3s. for each

night, or portion of a night, for every arc lamp not lit, and 1s. for each night, or portion of a night, for every incandescent lamp not lit.

The boilers are to be of the most approved type and economical in the consumption of coal, engines to be of the best description of compound or condensing engines, efficiently controlled by suitable governors. The steam pipes must be covered with non-conducting material, and the boilers and engines must be so connected with one main steam pipe that any boiler or engine may be put in or out of work without affecting the remainder. The dynamos are required to be self-regulating and of high efficiency, to develop their full output without over-heating and at a moderate speed, to have also ample bearings and the best method of lubrication.

As a precaution against breakdown, there must be provided in the central station additional spare boilers, engines, and dynamos, with switchboard complete, to the extent of 50 per cent. of the power required to efficiently light the whole of the 920 lamps, arc and incandescent, and this spare plant shall always stand in readiness to be started instantly upon any breakdown or accident to the machinery which may at the time be at work. The switchboards must be of fire-proof material, provided with all necessary ampèremeters, synchronisers, cut-outs, and lightning arresters, and any other necessary regulating apparatus.

The cables must have a conductivity equal to 98 per cent. of pure copper, and to be of ample section to convey their respective currents without danger to the insulating material. The insulation to be high, and the insulating material to be capable of sustaining a hot temperature, without deterioration. Sufficient precautions must be taken to render a dangerous shock impossible, and the cables must be suspended at a minimum height of 25 feet overhead throughout the streets, provided that the working of the telephone is not injuriously affected by the electric lighting currents; in streets where this cannot be avoided the cables must be placed underground. There seems to be room for considerable variation here with regard to the insulation clause; it will depend a good deal upon personal conceptions of high and low resistance. With regard to the temperature question, the Corporation, in a circular which they kindly send with the specification, state that the temperature in Adelaide rarely falls below the freezing point, but it rises occasionally in summer to 150° Fahrenheit in the sun, and it has been known to reach as high as 176° in the sun and 118° in the shade. The climate is exceedingly dry and the rainfall infrequent. Cable manufacturers have here an excellent opportunity of proving the qualities of their cables. Nearly all the main streets have telephone wires suspended on one side of the road, and in one part of King William Street, between North Terrace and Franklin Street, the telephone wires are on both sides.

The Corporation will provide a site for the central station near the centre of the town, and in the case of Alternative tender A will also supply buildings. In the case of Alternative tender B a site for the central station will be provided by the Corporation and leased to the contractor at a rental to be mutually agreed upon, or in case of difference to be ascertained by arbitration in the manner previously mentioned. The Corporation has a free supply of water available for condensing and boiler feed, but contractors under Alternative tender B will have to pay for all water they may require. In case an alternating high tension system with distributing stations be adopted, the Corporation will provide sites for small cellars, to contain the transformers, in the public squares, reserves, &c.; in the case of a tender accepted under Alternative B, the contractor must provide his own sites.

The existing street gas lamp-posts and brackets are at an average distance apart of about 140 yards, and it is proposed that these shall be utilised for the incandescent lamps, each post to carry a lamp. The posts are about 9 feet in height, and have a socket of 2 inches diameter at top, into which the arm carrying the electric lamp may be fitted, or the lamps may be placed in the present lanterns. There are a few brackets attached to various buildings. The existing number of lamp-posts is 748, and of brackets 67. The Corporation will provide the extra lamp-posts for incandescent lamps where required, but the contractor must provide the posts and all other means of suspension required for the arc lamps. The posts must be 30 feet high, and of a neat pattern, to be approved by the Corporation engineer. The arms and fittings for the incandescent lamps must also be provided by the contractor. The arc lamps must be strongly made and well regulated, and must be provided with all necessary impedance coils and weather protectors, and have wired globes or lanterns. The arc lamps are to each take a current equivalent to 10 ampères at 50 volts. The incandescent lamps are to give a light of 32 standard candles at the ordinary electrical working pressure of the installation, and to be provided with all necessary safety fuses and cut-outs, and reflectors and weather protectors. The poles carrying the electric light wires must be strong and of neat pattern, and made of galvanised wrought iron tubes. All insulators to be tested for high resistance before being used, and the cables to be suspended in the most approved manner to prevent injury to the insulating material.

In addition to the tenders specified above for Alternative B, tenderers must state a price for each additional extra arc and incandescent lamp, with lamp pillars and fittings complete, and connecting with the mains, also a price each per annum for lighting the same. The number of hours during which the lamps will be required to be lit, will be from sunset to sunrise daily throughout the year. Tenders must be endorsed on the outside of the envelopes, "Tender for electric lighting," and must be delivered at the Town Hall, Adelaide, before the hour of 1 p.m. on Monday, July 4th, 1892. Immediately upon the acceptance of his tender, the contractor shall execute a contract in writing, agreeing to perform the works and light the city in terms of his tender, which contract shall incorporate the foregoing specification and the usual general conditions of contract, and contemporaneously therewith the contractor shall pay into the hands of the city treasurer the sum of £500, which shall remain in his hands during the continuance of the contract, and upon neglect by, or failure of the contractor to carry out his contract, or to comply with the specification and conditions, such sum shall be forfeited to the Corporation; but if no such neglect or failure occur, then the same shall be returned to the contractor on the completion of his contract, or sooner purchase of the works by the Corporation under the power before-mentioned, and the ordinary bank interest upon deposits will be paid to the contractor in respect to such amount, so long as the same shall be held by the City Treasurer, and forfeiture of it shall not have been incurred under these conditions.

Tenderers are required to state the time they will require to erect and complete the installation, and to submit with their tenders sufficient drawings and detailed specification of the whole of the plant they propose to supply.

The specification closes with the usual proviso that the Corporation does not hold itself bound to accept the lowest or any tender. As a whole, it is a much more complete and workmanlike specification than the former one, some extracts from which I gave in a former letter. The first was signed by the Town Clerk, the latter bears the signature of Mr. J. H. C. Langdon, A.M.I.C.E., City Surveyor. Nothing is said as to whether the contractor is to have any rights with regard to private lighting in the event of an Alternative B tender being accepted. The position, marked on the plan which accompanies the specification, in which the Corporation intends to provide a site for the central station, is admirably suited for such purpose, being close to the railway station, Government House, Houses of Parliament, &c., and the principal hotels and places of business, and less than a mile from the centre of North Adelaide, the most important residential suburb. With an Electric Lighting Supply Bill before the Western Australian Legislative Assembly at Perth, Melbourne and Adelaide, calling for tenders for street lighting, and reports on public electric lighting adopted in Sydney and Launceston, there should be some work for Australian electrical engineering firms; and the sooner the better, as at present there is not enough work being done to keep going the many firms, hardly enough to enable to keep their staffs employed, and certainly not enough to make any big profits.

The Institution of Electrical Engineers.—Yesterday a paper, entitled, "Notes on the Light of the Electric Arc," by A. P. Trotter, B.A., member, was down for reading.

THE RELATION OF SIZE AND EFFICIENCY IN TRANSFORMERS.*

By L. B. Stillwell.

It is not intended in this paper to present an elaborate discussion of the relations of size and efficiency in transformers treated from a theoretical standpoint. If we were to select a certain type and, preserving for all sizes the same general proportions, agree upon a certain limiting temperature which all may be allowed to attain under working conditions, such a discussion would of itself be of interest, as pointing out the relations which exist between radiating surfaces and the amount of energy unavoidably lost in a transformer, but a thorough discussion upon such lines would involve a more or less elaborate comparison of the several factors which go to make up the sum of this loss, and for our purpose the possibilities of allowing greater loss in copper and less in iron, or greater in iron and less in copper, which are presented to the designer, are of less interest than a brief and necessarily general study of the effect of varying size upon the commercial efficiency of transformers as they are now offered by the manufacturer to the central station manager. Treatment upon these lines will also naturally call attention to other considerations of great practical importance, as regulation, insulation, and weight. The variation in difference of potential at secondary terminals, when the transformer is without load and when it is loaded to its full rated capacity, should be a minimum; the insulation should be such as to practically prevent the possibility of electrical connection of primary and secondary coils, and the weight should not be so excessive as to cause serious inconvenience in handling.

The designer of a transformer has presented to him alternative paths. He may easily design with reference to a very small loss of energy and relatively high efficiency at light loads, if he is willing to sacrifice regulation. He may design a transformer of little weight and large output, if he is content to work at a very high temperature, which may perhaps endanger the lasting qualities of his insulation. The best transformer is not necessarily that which has the lowest leakage or magnetising current; nor that which regulates most closely; nor that which is lightest and most easily handled; nor yet that which will carry its full load indefinitely with the least increase of temperature, but it is that transformer which best combines as much of each of these desirable properties as is practicable. In comparing various types, therefore, it is necessary to begin with a realising sense of the fact that the same laws govern all types as to design and performance, and that, under the general laws of physics which have to do with this class of work, extraordinary excellence in one respect is necessarily obtained at the price of sacrificing excellence with respect to other properties equally important.

A glance at the files of the technical journals, or an examination of the records of the Patent Office for the past five years, will show that a very large number of transformers alleged to embody certain new and useful improvements have been suggested; or, as their respective sponsors would say, invented. Fortunately we are not called upon to discuss all of these. Five years in the development of electrical apparatus is a long time, and, while it may not yet be said of transformers in commercial use that only the fittest survive, it is noteworthy, as it is for our purpose fortunate, that there is a general similarity of type prevalent in America, and the more general relations of size and efficiency obtaining in a line of transformers, as furnished by one manufacturer, obtain in all. I propose, therefore, without venturing further upon the domain of theory than is absolutely necessary, to glance at what may be called the geometrical relations of transformers of various sizes, and so invite the attention of owners and operators of central station plants to a subject of very considerable practical importance to them.

Let us take, as a starting point, a very small transformer; for example, one of five lights capacity, the primary terminals of which are connected to an alternating current circuit of 1,000 volts potential. We will suppose that the lamps which are connected to the secondary circuit are all turned off. Under these conditions a small current, called magnetising current, or leakage, flows in the primary coil. This current magnetises the iron and, as a result, we have in the primary what is called a counter E.M.F. Every transformer, small as well as large, which is connected to this dynamo circuit, must develop a counter E.M.F. approximately equal to that delivered to it from the dynamo. This counter E.M.F. depends upon the alternating magnetisation of a certain amount of iron, and the magnetisation of this iron means the expenditure of energy. The amount of iron required and the expenditure of energy necessary will naturally be less in a transformer of small capacity than in one of large capacity, but there must be some iron magnetised, and some energy expended in holding back the E.M.F. of the dynamo. It is safe to say that a commercial transformer, by which I mean a transformer that can be manufactured at a cost that will make it a commercial or saleable article, cannot be so designed as to have a loss of less than 20 watts, due to the magnetisation of the iron. A transformer twice as large—that is, of 10-lights capacity—is called upon to do precisely the same work and no more, is developing counter E.M.F. to oppose that of the dynamo, and may quite as easily be designed to work with an iron loss of 25 watts. If the rated capacity of the 5-light transformer is 250 watts and of the 10-light transformer 500 watts, the loss in the former will be 8 per cent. and in the latter 5 per cent. A 20-light transformer may as easily be designed to work with an iron loss of 30 watts, and a 40-light transformer with an iron loss of 45 watts; the percentage of loss in these cases being, respectively, 3 per cent. and 2·25 per cent.

One 10-light substituted for two 5-light transformers will reduce the amount of energy lost in magnetising the iron from 8 to 5 per cent., a saving of 3 per cent. One 40-light substituted for two 20-light transformers will reduce iron loss from 3 per cent. to 2·5 per cent, a saving of one-half of 1 per cent. About the same percentage of saving can be effected by again doubling the size, and 100-light transformers can be furnished in which the iron loss does not exceed 1·7 per cent. Beyond this figure it is easily seen that improvement is difficult, and even were it possible, by employing a very large transformer, say, one of 500-lights capacity, to reduce iron loss to 1 per cent., the improving in efficiency resulting from the substitution of one of this size for five of the 100-light size would be but a fraction of 1 per cent., and in view of the necessarily greater weight and the obvious objections to putting a large number of eggs in one basket, the advisability of such substitution would be doubtful.

Thus far we have considered only the loss in iron when no current flows in the secondary circuit, and it will be sufficiently accurate for our purpose to assume that this iron loss remains constant under varying loads of the transformer. The loss of energy due to the resistance of the copper when no current flows in the secondary is negligible, since the magnetising current in the primary is very small, but this loss increases as the load on the transformer is increased, and the increase varies as the square of the current flowing; that is to say, the copper loss is four times as great when two ampères flow in the secondary circuit as when one ampère flows in that circuit. In the transformer without load we have a certain loss of energy designated iron loss, while in the transformer fully loaded we have this same iron loss plus the maximum copper loss. For intermediate loads we have approximately the same iron loss with varying copper losses dependent upon the amount of the load.

The loss due to the resistance of copper is generally about 2 per cent. This does not vary materially with a variation in size of the transformer, certain considerations having to do with regulation being largely accountable for this fact. If we assume that the loss in copper at full load for every size is 2 per cent., and that the iron loss is constant, irrespective of the load, the following table will, with sufficient accuracy, indicate iron and copper losses and efficiencies at full load. The table does not represent actual measurements of selected transformers, but is intended to fairly represent the proportionality of losses in transformers of various sizes. Actual tests will show results as good as or even better than the figures given in the table.

Capacity in 16 C.P. lamps.	Loss in iron.	Loss in copper.	Efficiency at full load.
5	8 per cent.	2 per cent.	90 per cent.
10	5 „	2 „	93 „
20	3 „	2 „	95 „
30	2·5 „	2 „	95·5 „
40	2·3 „	2 „	95·7 „
60	2·1 „	2 „	95·9 „
80	1·9 „	2 „	96·1 „
100	1·7 „	2 „	96·3 „
300	1·5 „	2 „	96·5 „

It will be seen that for sizes of less than 20 lights capacity the falling off in efficiency as we go down the scale of sizes is very rapid, while, on the other hand, the gain in efficiency of transformers larger than that of 20 lights capacity is much less marked. The exact significance of the table will, perhaps, be better shown by putting it in another form. Let us compare the losses at no load and at full load in 1,200 lights capacity of converters of each of the several sizes, and let us express the loss in each case in terms of the number of 16 C.P. lamps which the energy so lost would be sufficient to supply. We then have the following:—

Transformers used.	Loss at no load.	Loss at full load.
240 5-light capacity.	96 lamps.	120 lamps.
120 10 „	60 „	80 „
60 20 „	36 „	60 „
40 30 „	30 „	54 „
30 40 „	$27\frac{6}{10}$ „	$51\frac{6}{10}$ „
20 60 „	$25\frac{2}{10}$ „	$49\frac{2}{10}$ „
15 80 „	$22\frac{8}{10}$ „	$46\frac{8}{10}$ „
12 100 „	$20\frac{4}{10}$ „	$43\frac{4}{10}$ „
4 300 „	18 „	42 „

These figures plainly show that to supply any number of lamps up to 100 it is desirable, on the score of efficiency, to use a single transformer of the required size rather than two or more of less capacity.

For sizes of a capacity above 100 lights the improvement in efficiency is necessarily little, and although the argument on the score of efficiency is still in favour of the use of the large sizes, that argument is by no means as strong as it was before we passed the 100-light limit.

This properly finishes the discussion on the relation of size and efficiency in transformers as they are to be purchased in the market to-day, but there are certain other considerations very closely connected with the subject which will naturally influence a central

* Read before the Buffalo Convention of the National Electric Light Association, February 23rd, 1892.

station manager. I have left myself no space for a discussion of these points, but they are, for the most part, of a very obvious character, and it will be sufficient to simply mention them.

In favour of the use of large sizes is the very practical argument of reduced cost per lamp capacity. In giving proper weight to this consideration the purchaser should assure himself that the manufacturer has not effected a reduction in cost at the price of an excessively high limiting temperature, which may endanger the lasting qualities of the insulation.

Transformers of 300 or 500 lights capacity are naturally large and difficult to handle; or if they are not very large it will be well to again note the temperature.

An investment in a 500-light transformer is large as compared with an investment in one of 100 lights capacity, and the chances of accident, such as may be caused by lightning, are quite as great in the case of the former as in the case of the latter.

It is extremely improbable that a static discharge from the line caused by lightning will damage more than one of a group of five transformers which may be connected together in multiple arc, while a discharge which may break down the insulation of one of these will be quite as likely to damage a 500-light transformer.

In the discussion which followed, Mr. WM. STANLEY, JUN., differed with the author regarding a non-heating transformer, and stated that in his opinion the most efficient transformer that could be made would be the hottest transformer. "The problem of building a transformer is to build a coil of wire and get as much iron in it as you can; that is, to surround a given amount of iron with as many turns of wire as you can; or, to surround a given size or coil of wire with as much iron as you can." He thought that the table given of the efficiency of the various sizes was very good. Regarding his own recent work he said: "We have had occasion lately to design transformers of very high voltage, as high as 15,000 volts, and we are now designing some to deliver 40,000 watts, or 50 H.P. each. We find no difficulty in keeping the temperature of these transformers within reasonable limits. They will get hotter than a small transformer. It is better that they should; but I do not believe any well insulated transformer is in danger of breaking down. It depends on the kind of insulation. If you put in mica or paper, or any stratifying insulation, and subject it to a high potential, it will most certainly break down with that potential, by either a dynamic current or a static charge, or a stroke of lightning; but if you fit it with a homogeneous insulation, such as oil or some solid insulating compound, you can use any potential you want, provided the discharges do not take place that occur in stratified insulation. I think the heat has very little to do with the breaking down of a properly insulated transformer."

Prof. ELIHU THOMSON, praising the paper, said:—"It states facts, and facts which I have reason to believe are not far from the facts of truth. I do not exactly agree with Mr. Stanley in the statement that a transformer is better when it is hot. I would rather modify that statement in this way, that a transformer would run best if the iron would run hot and the copper as cool as possible; that is, the hysteresis losses of the iron would be diminished by the heat, and the resistance losses in the copper would be lessened by keeping it cool. If we could insulate the core of the transformer so as to prevent the escape of heat, and let it get hot, and keep the copper as cool as possible by ventilating it thoroughly, we would then have the ideal transformer. I hardly agree with the statement that Mr. Stanley made, that the insulation would not be injured by being hot. It is our experience that you cannot have a machine, a dynamo, or any other electric apparatus, run too cool, as regards the preservation of its insulation, provided it does not run so cool as to condense moisture from the atmosphere. The absolute resistance, the dielectric resistance, is highest when the substance is cool; that is, the tendency to puncture insulation is much less if you can keep your insulation cool. If you allow the insulation to heat up, its power of resisting puncture certainly decreases. The matter may be briefly stated in this way: if you take a good conductor like copper and run the temperature down, its resistance almost disappears at very low temperatures. Hundreds of degrees below zero, copper is almost a perfect conductor. If you heat it up it becomes more and more resisting. Let us take glass—a good insulator—or any insulating material, and run its temperature up, it loses its insulating power, and if we run it up until it gets to a red heat it approaches a conductor. All substances are conductors when they are hot enough."

Mr. STANLEY replied that he did not mean to imply that it would not injure the insulation of a transformer to have it hot. "What I did mean to say is, that so far as the efficiency of the apparatus went, it would rather, on the whole, be improved by heating it. Of course, we can heat a transformer up so high that it will get on fire; but there ought not to be anything to burn. I question if the transformer of the future will have cotton or any other inflammable material in it. We are making transformers in which, if the coil is cut in two, the copper wires will be found imbedded in a solid dielectric, and the section would resemble the section of a well constructed cable. There is nothing to burn there. A temperature change of 30 or 40 degrees would hardly affect the dielectric strength, while it would materially affect the efficiency of the apparatus."

Mr. STILLWELL closed by saying: "Prof Thomson has fully covered the points of Mr. Stanley's first remark, to which I applied the same criticism as the Professor. With regard to the possibility of making a transformer, using for insulation only such substances as are not affected by heat, while that may be a theoretical possibility, I do not think that any transformer is now offered in the market which will be found to embody that kind of insulation. If you use only mica or something of the kind which is not affected by heat materially, then, in general, I should agree with Mr. Stanley that it is well for the efficiency to let the transformer run at high temperature. As it is, however, nearly every transformer, so far as I have examined them, does use insulating tape, or an insulating substance resembling tape, in one form or another. It may not be necessary, perhaps, to be guided to any extent by foreign practice in these matters; but in so far as the foreign practice is found to be in line with correct theory, I think it is of some use to us; and it is very noticeable, in the specifications of foreign engineers, that they limit, both in machines and in transformers, to a comparatively low temperature. Anything that is done in the direction of reducing the temperature, either in generators or in transformers, by the manufacturing companies, is a direct gain to the purchaser; because I do not think it will be disputed that, taking the apparatus as it is built, such a policy tends to prolong the life of the apparatus."

REPORT OF THE GENERAL AUSTRIAN COMPANY AT VIENNA.

THE first ordinary general meeting of the above company has just been held, the President of the Council of Direction, the Aulic Councillor Leopold R. von Hauffe, in the chair. There were present 22 shareholders, representing 8,250 shares with 412 votes. From the yearly report for 1891, as delivered by the president, we extract the following:—

On the basis of the resolutions of the constitutive general meeting, the company, at the beginning of March, 1891, took over the central station, Neubad, erected by the firm Siemens and Halske, for electric lighting and the transmission of power in the inner city of Vienna, and with the sanction of the community of Vienna has entered into the place of this firm in the agreement existing between them and the community of Vienna. According to the agreements, the working of the central station acquired was to be conducted on the company's account from January 1st, 1891, where the present report has for its subject the working of the entire year.

The circle of consumers has been considerably enlarged during the past year. On January 1st, 1891, the number of the lamps supplied with electric current from the central Neubad (on the basis of 16-candle glow lamps) was 12,577 lamps, with 210 consumers. At the end of the year there were in action 22,504 lamps, with 440 consumers. The average duration of the lamps in the past year was satisfactory.

With the increased number of lamps is connected the extension of the conductive net. At the end of the year it reached the length of 23,405 metres, as against 16,399 metres at the time when the works were transferred. The number of the electro-motors in connection is hitherto insignificant, which agrees with the experience recorded elsewhere, that the use of electricity for the transmission of power makes very slow headway in the circles concerned. The directors hope, however, that the favourable results realised by consumers as regards hoists and ventilators actuated by electric power, will contribute to extend business in this direction.

The continually advancing extension of electric lighting in Vienna induced the directors to make provision for the erection of a second installation. They acquired to this end a plot of ground in the second municipal district, and they hope to set this new central station in action before the end of this year. The 1,672 shares of the Vienna Electric Company (Central Mariahilf), which have passed from the possession of the firm Siemens and Halske to the General Austrian Electric Company, are mentioned in the balance in the state of effects. The working installation of the Vienna Electric Company, as well as that of the Central Neubad, are conducted on the continuous current system of Siemens and Halske, and this undertaking, situate in the most industrial part of Vienna, is in continued development. Towards writing off the value of the buildings, machinery, leads, &c., the contribution of 40,000 florins was applied from the receipts of the past year. It is entered in the present balance as a dotation of the sinking fund for 1891. Further, the board of directors, making use of their statutory power, have formed a special renovation fund for the machinery, and have applied to this purpose the sum of 65,000 florins which accrued to the company from the firm Siemens and Halske, in consequence of the new overplus of the year 1890.

According to the profit and loss account, the past first business year, after writing off 40,000 florins, shows a net gain of 162,701 florins, being a return of nearly 5½ per cent. upon the paid up share capital of 3,000,000 florins. Of this, in the first place, a 5 per cent. dividend is to be distributed among the shareholders, that is, on 15,000 shares at 200 florins, each 10 florins, together 150,000 florins. Of the remaining amount of 12,701 florins, according to the proposal of the board, 2,000 florins will be assigned to the reserve fund, and the residue of 10,701 florins carried over to the next account. This proposal was unanimously accepted.

On the motion of a shareholder, Herr Fritzsch, the meeting passed a vote of thanks to the management.

NEW PATENTS—1892.

6,465. "Improvements in electrical secondary or storage batteries." G. E. HEYL. Dated April 4th.

6,467. "Manufacture of the alkaline carbonates or bi-carbonates by the electrolytic decomposition of alkaline chlorides in the presence of gelatinous alumina or chloride or other salt of aluminium." E. HERMITE and A. DUBOSC. Dated April 4th.

6,487. "Improved hot air, vapour and electro-therapeutic bed-bath apparatus." F. A. Dubois de Dunilac. Dated April 4th.

6,551. "Improvements in electric recording devices for mariners' compasses and other instruments." C. L. Jaeger. Dated April 5th. (*Complete.*)

6,569. "Improvements in telephone cables." J. E. Kingsbury. (Communicated by the Western Electric Company, United States.) Dated April 5th. (*Complete.*)

6,579. "Improvements in alternate current electro-motors." M. Deri. Dated April 5th.

6,629. "Telephone call apparatus." Siemens Bros. & Co., Limited, and F. Jacob. Dated April 6th.

6,635. "Improvements in or connected with moulds for casting ribbed metallic plates, more especially intended for use for casting plates for secondary batteries." A. S. Bower. Dated April 6th.

6,637. "Improvements in electrodes for storage batteries." G. E. Heyl. Dated April 6th.

6,694. "Improvements in electric hair and skin brushes." G. I. Spalding and R. L. Hawkins. Dated April 7th.

6,698. "Improvements in and relating to dynamo-electric machines, electric motors, continuous current transformers, and the like." H. G. Jackson. Dated April 7th.

6,707. "Improvements in the method and apparatus for registering supply of electricity." G. Kapp. Dated April 7th.

6,720. "Improvements in dynamo-electric machines." J. A. Kingdon. Dated April 7th.

6,722. "Improvements in battery plates or secondary batteries." W. W. Donaldson and R. Macrae. Dated April 7th. (*Complete.*)

6,725. "The manufacture of electrical fires." G. E. Tucker. Dated April 8th.

6,726. "Improvements in multiple switchboards for telephone exchanges." R. Pippette. Dated April 8th.

6,775. "A new or improved electrical apparatus." T. Higginson-Wolstencroft. Dated April 8th.

6,785. "Improvements in electrically controlling the levers of railway signal interlocking apparatus." L. B. Stevens and W. R. Sykes. Dated April 8th.

6,839. "Improvements in means for electro-plating the interior of tubes and other hollow articles." J. E. Bott and C. G. Norris. Dated April 9th.

6,861. "Improvements in electrical heating apparatus." G. Binswanger. Dated April 9th.

6,868. "Improvements in dynamos or motors." R. C. Kintzing. Dated April 9th.

6,870. "Holding telephone receivers (viz., that part of a telephone through which the communication is heard), against the ear." A. D. Mokies. Dated April 9th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

(*The Price of all Specifications is now 8d. each.*)

1,192. "Means and apparatus for propelling boats and rafts on water ways by means of electrical energy." O. Busser. Dated January 22nd. There is installed upon each boat to be propelled, firstly, a mechanism whereby it can be propelled automatically upon a fixed cable or chain laid on the bottom of the waterway, in a similar manner to that now employed, and, secondly, there is provided the necessary force externally of the boat for driving such mechanism. The motive power employed for this purpose is electrical energy produced at central stations on the banks of the waterway, from which it is passed into suitable overhead conductors extending along the waterway. 3 claims.

2,219. "Improvements in electric arc lamps." C. E. Lever. Dated February 6th. Claims:—1. In an arc lamp the combination of an arc regulating shunt solenoid, serving also as a dash-pot and an adjoining cut-out magnet with resistance coil, a double lever actuated by the solenoid core and having an armature for the cut-out magnet, a spring for pulling back the lever, a clutch ring connected to the lever for gripping and raising the upper carbon holder when canted, and a bed-plate with gallows frame wherein the aforesaid parts are contained, substantially as set forth. 2. The construction of the lamp shown on the drawing.

2,866. "Improvements in electrical measuring instruments." H. H. Lake. (Communicated from abroad by E. Weston, of America.) Dated February 17th. The principal features of the instrument are the form and arrangement of the magnet and the disposition of the coils therein, the devices for transmitting motion from the moving coil to the index, whereby a slight movement of said coil is caused to produce large movement of the index, and the general disposition of the parts, whereby the instrument is rendered very sensitive in operation, accurate in measurement, not influenced by induction from exterior sources, and capable of measuring currents of great strength without injury. 3 claims.

3,357. "Improvements relating to the jacketing of pipes and cocks, chiefly designed for use in connection with vacuum pumps for exhausting incandescent electric lamps." H. H. Lake. (Communicated from abroad by A. Berrenberg, of America.) Dated February 24th. (6d.) Claim:—in connection with a system of vacuum pumps the combination of a socket piece adapted to receive a key or the socket end of a "fork," and having passage connections with the vacuum system; with a jacketing piece, having passage connection with a jacketing system as described, substantially as and for the purpose set forth.

4,099. "Improvements in electric arc lamps." W. H. Akester. Dated March 7th. The runners which carry the carbon holders are constructed in the ordinary manner, that carrying the positive or upper carbon being heavier than the other. The said runners are arranged in the usual manner, to slide up and down on the two vertical side rods of the lamp. A chain which passes over a sprocket or other similar wheel or pulley at the upper part of the lamp, has its ends respectively connected to the two runners. At the upper part of the lamp, in close proximity to the before-mentioned wheel or pulley, is arranged a solenoid provided with a movable soft iron core, in connection with the lower end of which is an eccentric block mounted on an arm which is loose on the wheel spindle, so that on the upward movement of the said core, the eccentric block will be turned on its centre and brought into contact with the periphery of the wheel or pulley, and will partially revolve the same in a direction contrary to that in which it is revolved, when free, by the weight of the runner carrying the positive carbon holder. The said arm is restrained at any predetermined normal position by means of a spring or weight and a suitable stop. 2 claims.

4,263. "Improvements in means for preventing induction in telephones." T. F. Wright and E. G. Wilson. Dated March 10th. Relates more especially to a device attached to the receiver.

5,067. "A system of economic and private telegraphing, with apparatus and appurtenances therefor." H. Lassen. Dated March 21st. Relates to a "slide" code apparatus. 4 claims.

5,135. "Improvements in armatures for dynamos or electric motors." B. D. Southard. Dated March 23rd. Consists broadly in dividing the cylindrical core longitudinally into sections, each of which supports one or more of the coils of the wire, and in so uniting the sections and supporting them from the shaft or arbor that any one of them, or any number, may be taken out, without disturbing the others, by simply disconnecting the coils to be removed, from those adjacent thereto. 7 claims.

5,192. "Improvements in electric clocks." W. S. Scales. Dated March 24th. Consists in the combination with a clock train, a step-by-step driving mechanism therefor, an electro-magnet and its armature that operates or causes the operation of said driving mechanism, of a regulating member for said clock which also operates or causes the operation of said driving mechanism in case the armature of the electro-magnet fails. Also in an electric clock, a train, a step-by-step driving mechanism therefor, an electro-magnet and its armature that actuates the said driving mechanism, a regulating member for the train which actuates said driving mechanism in case the armature fails, combined with a propeller for said regulating member and a circuit closer for the electro-magnet, moved in one direction by the regulating member and in the other direction by the armature. 5 claims.

5,547. "Improvements in apparatus for electrolytic decomposition." C. Kellner. Dated March 31st. Comprises a number of single cells for the electrodes, each cell being formed by a frame covered with a suitable diaphragm. The space enclosed by the frames communicates at the lower part with the supply of the liquid to be decomposed, whilst at the top it is connected with the outlets for the ions by perforations formed alternately on the left and the right in the successive frames. 4 claims.

5,595. "Improvements in electric heating apparatus." M. W. Dewey. Dated March 31st. The inventor combines an electric heater with a suitable ventilating fan, operated by a motor of any desired construction, but preferably an electric motor to displace or remove the heated air from the heater. 15 claims.

5,637. "Improvements in electric converters." R. W. Barker. (Communicated from abroad by M. G. Farmer, of America.) Dated April 1st. The inventor uses very thin sheets of non-magnetic metal, each of which, together with two magnetic laminæ, soldered or sweated to it, constitutes a core element, and all these elements may be assembled to build up a core of any desired cross-section in an expeditious and easy manner. 7 claims.

CORRESPONDENCE.

High Pressure Transmission.

In a communication to this paper of March 18th, I referred to a series system of distribution of large powers long distances. Though there are no Niagara falls in this country, there are several sources of power to which the system might be applied.

In Scotland and Wales there are numerous small falls, which if put in series with one another, would totally yield at any one point, considerable power; the same would apply to the electrical connecting up of groups of wind or tide mills.

It would be interesting to have particulars of any tide mills now in practical operation.

George Edensor Dorman.

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

Siemens's Railway Signalling Apparatus.

(*Continued from page* 498.)

Another, and even simpler way, of fastening the gongs with their iron protecting cover to a house, is shown in fig. 4. This cover, with two gongs of 20 inches and 16 inches diameter (equal to 50 and 42 cm. respectively), is fastened to a tubular support, with flanges attached, for fixing it to the rafters of the house. The cords of the striking gear pass up through the hollow central portion of the support.

Experience has proved that gong apparatus placed on iron pillars are preferable to those situated at the very huts of gate-keepers; hence the latter arrangement is only exceptionally adopted. There are, however, many cases where gong apparatus has to be placed on brackets, attached to the wall of a station building, or within a tunnel, &c., in which cases the clockwork is protected by a strong watertight iron casing, and the gongs are provided with or without a cover, as circumstances may require.

The electro-magnets of the gong alarum can be operated by voltaic batteries; but as such currents are liable to vary in strength, a frequent re-adjustment of the antagonistic spring of the armature would be entailed, a most inconvenient arrangement, which ought to be avoided. Magneto-inductors are, on account of the perfect constancy and greater strength of their currents, preferable for the working of gong alarums. These inductors are generally constructed to produce continuous currents, and have 12 permanent magnets and two keys.

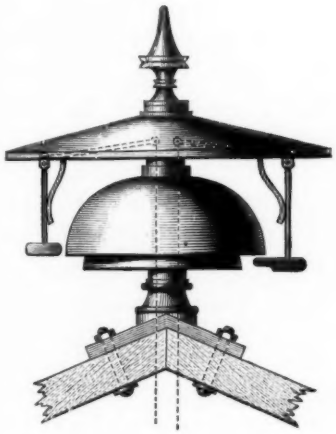


Fig. 4.

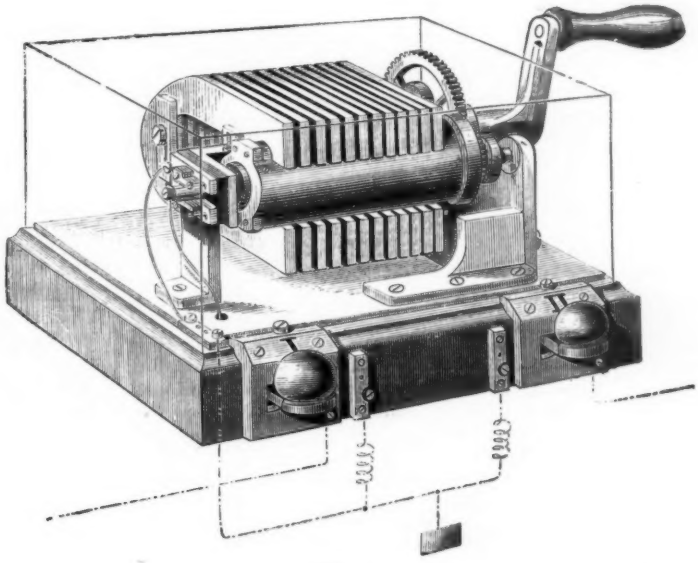


Fig. 5.

The magneto-inductor, shown in fig. 5, consists of 12 permanent magnets, between the poles of which a Siemens armature is caused to rotate when the handle of the inductor is turned. Each complete rotation of the armature produces two currents in opposite directions in the coil of insulated wire, wound on the armature, and as one revolution of the handle causes the armature to revolve 13 times, 26 currents, alternately positive and negative, are generated in the insulated wire-coil of the armature for one complete turn of the handle. But, by means of a commutator attached to the axis of the armature, these alternate currents are, before entering the line, brought into one direction, so that a continuous current of considerable intensity is thus produced. By simply interchanging the two short leading wires, which connect the contact springs with the terminals of the inductor board, either continuous positive or continuous negative currents can be sent into the line, a circumstance which is, as will be seen later on, of importance in such cases, where the one line is used both for the conveyance of voltaic currents on the closed circuit system for giving automatic signals for help, and for the conveyance of magneto-inductor currents for the ringing of the gongs. In such cases the continuous open circuit inductor current and the closed circuit voltaic current must be of the same polarity.

Magneto-inductors are mostly provided with two keys (see fig. 5), which are similar to ordinary manipulating keys. Inductors with only one key are sometimes used at terminal stations, but at intermediate stations two keys are required, so as to work the "up" and "down" wires with the same inductor. As long as these keys are in their position of rest, that is to say, not pressed down, both lines are connected direct to earth, and the magneto-inductor is out of circuit.

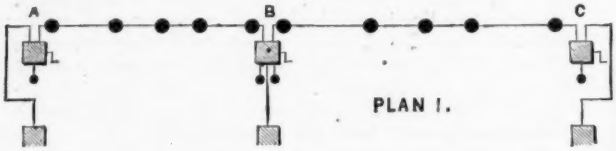
To send an inductor current into the line, one of the keys must be depressed while the inductor handle is turned, whereby the home-receiving instrument (bell or recording apparatus) is cut out of circuit, and the current entering the line sets the gongs sounding. These magneto-currents, being of constant strength, have the important advantage over battery currents, that the adjustment of the gong-alarum apparatus, when once made to suit the strength of the current, requires but little further alteration.

Magneto-inductors with less or with more than 12 permanent magnets are sometimes used for exceptionally short or for very long lines, but those made with 12 magnets are suitable for most cases. For instance, a line of 9 to 10 English miles (say 15 kilometres) length, made of iron wire of 4 mm. diameter (No. 8 wire), and including 15 pillar gongs, can be readily and reliably worked by a 12 magneto-inductor, even with the antagonistic springs of all the electro-magnets of the gong apparatus fully strained.

As the principal object of gong signalling consists in giving a timely and reliable information of the approach of a train to those men, placed along the line, whose duty it is to look after the gates at level crossings, or who have to perform similar duties necessary for the security of the traffic, it follows that, if possible, alarum wires ought to be used exclusively for the purpose of this signalling, and general telegraphic communication ought not to be permitted on such lines. Notwithstanding this, Siemens's system of gong signalling is such that it allows the using of one single wire

for both purposes, viz., for telegraphic communication between stations, and for alarm signalling between station and gong pillars.

The simplest combination of a gong alarum circuit is shown in plan 1, representing a gong line with two terminal and one intermediate railway station, and with five gong



PLAN I.

pillars along each section of the line. The magneto inductors at the terminal stations A and C have only one key each, while the inductor at the intermediate station B has two keys. At this latter station two gong pillars are shown in close proximity to one another, the one for the up and the other for the down line, and hence, in order to have a distinct difference between the audible signals from these two apparatus, one of the pillars is provided with only one gong, and the other with two.

The gong signals are always sent by means of the magneto-inductor, and generally from the home station to the next station, and are simultaneously heard at all the pillars on that section of the line.

Supposing the pins at the face of the barrel wheels (see figs. 1A and 2, pages 497-498) to be so arranged that the alarum produces, when set in rotation, four consecutive gong strokes, viz.: ● ● ● ●; then a number of signals could be conveniently combined, and pre-arranged meanings attached to them, such as for instance :—

One turn of the inductor handle ● ● ● ● to mean an "Up train."

Two turns of the inductor, with a short space of time between: ● ● ● ● ● ● ● ● to mean a "Down train."

Five turns of the inductor with short space between each turn :—

● to mean "Stop all trains."

The aggregate number of strokes, forming the element of these signals, could be varied, so that instead of composing each element of four strokes as above, 2, 5, 6, 10, or more could be adopted, according to the number of projecting pins attached to the face of the barrel wheel. Should three distinct gong signals not be sufficient, others, composed of 3, 4, and more elements, can be conveniently added. As these signals are heard simultaneously by all the gate-keepers of that section of railway, these men are thus not only informed of the departure of a train, but also of its direction, so that they can attend to their respective duties in proper time.

In many cases it is not considered sufficient to be able to send gong signals only from the stations to the gate-keepers, but it is also desired that the gate-keepers should possess the means of sending a few alarum signals (or "signals for help," as they are called) from their respective pillars towards both the up and down stations, so as to meet certain emergencies on occasions of danger, accidents, or service convenience. To attain this object, the recourse was taken of a closed circuit battery current passing constantly from station to station through all the gong pillars, so that in this case the line wire has to convey not only the occasionally required magneto inductor current for ringing the gongs, but also a closed circuit battery current flowing continually through the line wire, and the electro-magnets of all gong pillars and station receiving apparatus (bell or recording instruments). This continuous battery current is not strong enough to attract the armatures of the gong apparatus, and hence it cannot release the striking gear, which is only effected by the much stronger magneto-inductor currents; if, therefore, a trembling bell, or better, a Morse recording apparatus, be placed at each station, any interruption of this closed battery circuit announces itself at the receiving apparatus of both stations.

To send automatically a small number of "signals for help," each pillar is provided with a convenient number of loose contact discs (see fig. 2), each disc representing a certain pre-arranged signal for help. Four or five of these are generally considered sufficient to meet the ordinary requirements of the service. The clockwork is used to set the disc in rotation, and this latter, after having been selected in accordance with the signal for help required to be sent, is taken from its resting pin and placed on a projecting spindle of the clockwork, as is shown in fig. 2 with signal disc No. 1 (Send Help).

The clockwork is then started, the disc rotates, and its periphery suitably indented acts upon a contact lever, breaking and closing the line circuit during its rotation in strict accordance with the undulated periphery of that disc. These manipulations of the disc and contact lever act in the same way as a closed circuit Morse key, the result of which is, that the receiving instruments, at both the up and down station, reproduce such automatically sent signals, by either a trembling bell, a sounder, or an ink recorder as the case may be. In the latter case the paper motion of the receiving apparatus must be self-starting.

After the stations have acknowledged the receipt of a signal for help, by ringing all the gongs a pre-arranged number of times (by which not only the line man who sent the signal for help, is informed that he has been understood, but also all other men at gong pillars are informed that some signal for help has been given on their section of line), the contact disc is again removed, and the closed circuit battery current remains uninterrupted, ready to convey any other automatic signal for help whenever required.

The indentations on the periphery of the discs not only correspond to the nature of the help required, but they also indicate a number, representing that gong from which the call for assistance has emanated. Each disc, therefore, bears two distinct letters of the Morse code, one indicating the gong from which the signal is sent, and the other representing the kind of help required. The following combination of signs might, for instance, be adopted :—

Contact disc.		Signal for help.		Signification of signs.
Pillar No.	Disc No.	Pillar code.	Alarum code.	
1	1	• — •	— •	Engine broken down at pillar No. 1.
1	2	• — •	— — —	Train off the line at pillar No. 1.
1	3	• — •	— — — ••	Stop all trains by wish of the pillar No. 1.
1	4	• — •	— — •	Auxiliary engine wanted at pillar No. 1.
1	5	• — •	— — — •	Men and doctor wanted at pillar No. 1.

The five contact discs for the second, third and other pillars, would be similar to those of the first pillar, with the exception that each set would have a different pillar code number, whereas the alarum code would remain the same for all gong pillars of the entire railway lines.

In many cases, an ordinary Morse circuit breaking key is also attached to each pillar apparatus (see figs. 1A and 2), thus enabling telegraphic messages to be sent from any of the pillars to the stations, and in order to receive telegraphic messages at the gongs, the pillar apparatus is further provided with a commutator (see also figs. 1A and 2), consisting of a metal connecting strap which remains when not used, firmly screwed in a horizontal position by means of two thumbscrews. Should, however, a receiving instrument be temporarily introduced into the gong circuit, for the purpose of receiving telegraph messages at the pillar, then the commutator strap is opened and the receiving instrument attached to the two thumbscrews. Such an arrangement is often employed when either foremen of gangs of men, or guards, having a portable receiving instrument in their breakvan, wish, in case of urgency or necessity, to communicate with the stations. After the conclusion of such communication the receiving instrument must be removed, and the commutator strap firmly secured to its original horizontal position.

(To be continued.)